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Dear Committee

Inquiry into the potential use by the Australian Defence Force of unmanned air, maritime and land platforms

Thank you for the invitation to contribute to this timely and important national inquiry.

Unmanned platforms have developed exponentially over the last two decades and permeate an increasing range of military and civilian spaces. Whilst it is impossible to completely predict the social, ethical and legal outcomes of these advances; prospective and measured regulatory responses are vital if we are to effectively manage the risks and benefits they pose.

RELEVANT PUBLICATIONS, ANALYSIS AND EXPERTS

I attach a co-authored background paper from the *Journal of Law, Information & Science* (JLIS) written in 2008 – updated in 2010 (Attachment 1)/2012(Attachment 2) – which provides a broad account of legal issues arising from unmanned military technologies. The paper served as a *précis* for a dedicated volume of commentaries and opinions in the JLIS by a range of noted international legal experts. I would recommend that special edition of the JLIS to the Committee. It is available electronically at:

- http://www.jlisjournal.org/content/drones.html

The special edition is also available in hard copy from the JLIS.

Many of the authors who contributed to the JLIS special journal edition are Australian, and those from overseas may also be available to answer the Committee's questions. I would also note the extensive Australian expertise on this matter centred at the Centre for Military & Security Law, ANU.

SUMMARY POINTS

I summarise the main points from the attached papers on UV technology with respect to relevant points of the Committee's Terms of Reference below:

ROLE IN INTELLIGENCE, RECONNAISSANCE AND SURVEILLANCE OPERATIONS, INCLUDING IN SUPPORT OF BORDER SECURITY, CIVIL EMERGENCIES AND REGIONAL COOPERATION

Unmanned platforms promise clear benefits in all of these spaces. UVs are unquestionably revolutionary, and it is vital Australia is not left behind the rest of the world in this revolution. But it is equally important we do not proceed forward down the wrong path. Unqualified claims about the benefits of a technology should be approached with as much caution as uninformed claims about their risks. The law has an important and central role in facilitating the introduction of new technologies in a manner which maximises their benefits, reduces public concerns and backlashes and avoids hazards and risks.

CHALLENGES, OPPORTUNITIES AND RISKS

As noted above both claims of benefits and risks need to be approached with precaution and objectivity. UVs alter the way humans interact with the world (in some cases removing humans from certain spaces altogether) which will create imbalances and instability in established systems. History shows that we rarely entirely comprehend or predict the impacts of the introduction of a new technology until it has been fully implemented and sometimes long after it has become mainstream. This is already clear in the short history of UV usage, for instance:

- Drones experience much higher accident rates than manned vehicles (up to 100 times higher), but the reasons for this are more complex than simply technical. In fact they are more related to controller complacency and the reduced feedback that results from removing a pilot from the cockpit (who has an interest in her/his , own self-preservation) as much as they relate to technical faults.
- Drone use has been both a response to, and significant driver of, asymmetrical warfare, pushing insurgents into civilian areas for shelter. That in turn has increased the need for unmanned technologies capable of more specific targeting to reduce civilian casualties – accelerating the asymmetrical paradigm shift in modern warfare.
- UVs extend the reach and presence of border control and law enforcement services, but their commercial accessibility has also facilitated crime and allowed criminals to avoid detection.

The challenges, opportunities and risks associated with the deployment of UVs will constantly shift and change as the technology advances, becomes more ubiquitous and integrated into military and civilian spaces, and society more generally.

While this inquiry is a very important first step, the transition necessitates long-term management both within the defence force and outside of it. To that end I would urge the Committee to consider the importance of establishing a more permanent national review and advisory process for unmanned technologies.

A looming risk: an autonomous arms race

That said, one of the implications of unmanned technologies which I believe the Committee should consider as a serious long term concern requiring immediate and wide ranging action is the issue of full autonomy, and in particular full weapons autonomy.

Many of the forces driving UV development seem to be militating toward increasing weapons autonomy. That is, UVs that can fire on other vehicles or persons without human control or veto.

A computer without human restraints will always be faster than one with some form of human control and therefore, realistically, once one nation has fully autonomous weaponised UVs the others will follow. That situation may be fifty years away, or it may be five, but ultimately, now is the best time to have the debate about whether the community is willing to accept such a future. If it is determined that full weapons autonomy is not an acceptable path then Australia will have to participate in, or even lead, international dialogue towards effective regulation and restriction of such technology.

DOMESTIC AND INTERNATIONAL LEGAL, ETHICAL AND POLICY CONSIDERATIONS

As noted the ethical, legal and policy considerations arising from UV technologies will vary as the technology does, but (highlighting relevant points from the attached paper) the Committee may consider the following:

Domestic

- *Tort, Negligence and the Question of Fault.* UVs have proven reasonably unreliable and subject to faults, errors and accidents: who will be responsible for injury or damage they cause if used in public spaces? Will that be software and hardware developers; manufacturers; systems engineers; operators; or those who decide to deploy them, or set the parameters for their deployment?
- *Traffic law.* UVs are already being used on civilian roads. This raises questions about traffic laws, licensing, and control of such vehicles.
- *Civilian aerospace law.* Commercial UAVs are currently sold in Australia. CASA has been vigilant in this respect and has passed extensive regulations. I expect that the Committee will consult with CASA directly on this matter.
- *Use of Evidence*. New technologies allow for broadened information gathering techniques which may present procedural challenges for courts and tribunals. DNA evidence is one example of this; courts and lawyers having struggled with how to integrate the technology into legal practice. Originally rejected as admissible by courts, DNA evidence then became overly relied upon as infallible; which was later proven to be false. It is now used in a more conservative, balanced manner, but there were several miscarriages of justice on the path to our current use of it. Enforcement agencies will need to work with regulators and legal experts to ensure information gathered by UV platforms facilitate rather than undermine the administration of justice.
- *Domestic weapons control*. UVs are not *strictly* weapons, insofar as they may have a range of uses, and carry a variety of on-board systems which have non-military utility. Conversely, they are extremely capable weapons platforms and are increasingly being designed to take the place of manned fighter craft.

  - Relatively inexpensive UVs of all types can already be constructed from hobby kits and fitted with weapons, including a new generation of recoilless gun, designed specifically for small-unmanned systems.
  - They also serve as cheap and easy explosive and biological agent delivery platforms.
  - Last month (28 January 2015), a $400, off the shelf, semi-autonomous quadcopter was landed on the grounds of the Whitehouse in the U.S. Although an apparent accident the incident caused a serious security scare, not least because the same type of drone has been used by Syrian rebels as explosive platforms against armoured vehicles in that country; with marked success.
  - The Committee might consider the use of UVs for terrorist activities and the intentional and unintentional interference with public infrastructure.
  - The Committee might consider controls on military grade, or weapons capable UV systems for commercial sale.
  - The Committee might consider 'no go zones' for UVs. The U.S is currently considering extensive no-fly zones for public infrastructure and security installations. I note that a range of ground based UGVs are also capable of delivering payloads and are designed to scale or jump security fences or access. Any prohibition on UVs must apply to more than airspaces.

- *Privacy. UVs, particularly UAVs* were developed, in very large part, to allow for global, persistent surveillance of war-zones. Their adoption into the civilian world will provide the same surveillance capacities to those controlling them; capacities far beyond those envisioned by the courts in this country in their rejection of a tort of privacy. Is it acceptable to use this technology in non-conflict zones? Specifically, what are the privacy implications of using such platforms to allow for constant monitoring of civilian populations? I have included a separate paper on that issue with this submission (Attachment 3).

International

IHL – I note that this area was dealt with by my colleague in the background *precis,* and a range of experts wrote opinions on the use of Unmanned Vehicles in the special edition of the JLIS, including Professor Philip Alston, who also drafted the UNGA Report on Targeted Killings as Special UN Rapporteur on extrajudicial, summary or arbitrary executions, Doc A/HRC/14/24/Add.6 (28 May 2010).

Civilian airspace laws. At present international law discriminates between manned and unmanned aircraft in civilian airspace, pursuant to Aritlce 8 of the 1948 *Chicago Convention on International Civil Aviation ('Chicago Convention')*, which provides for international regulation of civilian air traffic. Article 8 of that Convention states: "No aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a Contracting State without special authorisation by that State". Resolving such issues will arguably require a mixture of technical improvements and regulatory review.

International oceans and waterways.

1. Under the 1972 IMO *Convention on the International Regulations for Preventing Collisions at Sea* requires that UVs clearly signal their status as not being under

command or under restricted manoeuvrability and makes them responsible for any collision with another vessel.

2.The 1979 *International Convention on Maritime Search and Rescue* (SAR) obliges vessels to 'retrieve persons in distress, provide for their initial medical or other needs' and 'deliver them to a place of safety.' But does not distinguish between manned and unmanned vessels.

3. Current maritime practice is to 'consider unmanned vessels to be abandoned,' leading masters of vessels to tow UMVs to the closest port for salvage compensation pursuant to the 1989 IMO *Salvage Convention*.

4. It is unclear whether USVs would be granted 'innocent passage' through the territorial sea of states under the *United Nations Convention on the Law of the Sea* (UNCLOS).

- Excluded from 'innocent passage' under UNCLOS are a range of activities that may well be undertaken by UVs. These include: any exercise or practice with weapons of any kind; the launching, landing or taking on board of any aircraft or military device; fishing activities; and the carrying out of research or survey activities.

5. Naval UUVs / USVs may contain highly valuable hardware, data or state secrets, it will be important for Australia that its UVs are granted sovereign immunity. However, whilst UNCLOS does not define what a state ship on 'non-commercial' duties is, it defines 'warship' as a vessel *inter alia* 'under the command of an officer' and 'manned by a crew which is under regular armed forces discipline'. This would seem to preclude UVs.

6. *Weapons non-proliferation treaties.* The purchase and sale of military UVs must comply to the international weapons non-proliferation agreements to which Australia is a party. These include the *Wassenaar Arrangement* and *Missile Technology Control Regime.*

7. *International agreement on weapons autonomy*. As noted above a particularly important area of international legal dialogue must centre upon the question of UV weapons autonomy. Australia could use its position on the Security Council to encourage international cooperation on this issue.

WHAT FORM OF REGULATORY OVERSIGHT?

As noted above, measured regulatory oversight serves to facilitate, rather than hinder the introduction of novel technologies that promise clear benefits. However any regulatory agenda should be informed by the nature of the technology; if too specific and overly precise they will "prove too rigid to operate effectively … because [novel technologies] evolve too quickly for such legislation to respond. In such cases the emphasis should be on the separation between acceptable or unacceptable rather than on the form of [technology] itself. This will assist in constructing clear boundaries between ethical and unethical [uses' and hence create clarity in the law and assuage public distrust". (http://jme.bmj.com/content/29/2/84.full)

It should be recongised that UVs merely amplify certain legal, ethical, social problems due to their ability to extend the reach and influence of human actors. Consequently it is preferable, in most situations, to extend the reach and influence of existing regulatory systems rather than create specific ones which are likely to be bypassed or made redundant by a rapidly developing technology. Using existing regulatory regimes need not create a disparate and uncoordinated response if it is led centrally, by an expert body with cross-institutional representation and consultative powers.

There are two main exceptions to this. The first is the possible need to to establish a moratorium on fully autonomous weaponised UVs before they are introduced into military practice – or worse the civilian marketplace. That will allow the public to fully debate whether this form of technology is permissible or not. Australia should take the lead on such a moratorium.

The second relates to surveillance, border control and policing and more broadly to the commercialisation of UVs. That is to consider whether the introduction of these new technologies should be a catalyst for introducing more stringent privacy legislation. That is because our common law traditionally considered that, if you wished to have privacy, you should build your own fence. UV technology makes fences redundant, indeed it even makes brick walls redundant. Whether the public is comfortable with the widespread use of a technology designed to, in part permit global, persistent surveillance is uncertain, but it is very likely they would not be happy to discover they may be surveilled in their back yards or living rooms. It may be the only way to assuage such concerns is to develop a national obligation to afford reasonable privacy to all citizens.

I reiterate my thanks to the Committee and belief that this is a timely and exceptionally important inquiry, which, I hope, will mark an ongoing consideration of UV technologies in this country.

Sincerely,

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The Laws of Man over Vehicles Unmanned: The Legal Response to Robotic Revolution on Sea, Land and Air

BRENDAN GOGARTY AND MEREDITH HAGGER

Abstract

This paper examines the recent proliferation in unmanned vehicles (UVs) in both military and civilian use. Over the last decade unmanned vehicles have played an increasingly central role in armed conflict and a growing role in civilian affairs. The use of such vehicles is challenging the boundaries of existing legal frameworks and presenting a range of social and ethical concerns. Despite this, there has been a relatively small amount of legal debate on the consequences of removing human operators from vehicles and even less in the way of legal reforms to deal with what is now a practical reality in many environments across the globe. This article therefore provides an overview of some of the legal, social and ethical issues presented by unmanned vehicles as a précis to further discussion in a special edition of this journal.

1. Introduction

It is often much easier to design a machine which can fly, float or even move across ground if you do not have to worry about the various needs of, and risks to, a human operator within it. As such, unmanned vehicles have existed for as long, if not longer, than manned ones. However, without a person aboard those vehicles to steer or pilot them their use has traditionally been limited. As such, unmanned vehicles have typically been much less useful and prominent than manned ones; at least until recently. Over the last decade unmanned vehicles have played an increasingly central role in armed conflict and a growing role in civilian affairs.

In this article we will examine the current state of unmanned vehicle (UV) technology and consider some of the legal issues they raise. We will begin by defining the key terms of art relating to UV technology. This is important, in part due to the technical nature of modern UVs, but also because the rapid contemporary growth in unmanned technologies has meant an agreed vernacular to describe them has not yet developed. We will subsequently set out a brief history of UVs, prior to the turn of the century and then consider why their use has exploded following it.

In the second part we will discuss first, the military application of UVs and the issues, particularly in respect of International Humanitarian Law, that they raise. In the second part we will consider the civilian transition of modern UV technology. Whilst UVs are only beginning to be used for civilian applications they already appear to raise human rights, torts, criminal and regulatory issues.

In the final part of the paper we consider the future for unmanned vehicles. In that part we discuss the proliferation of military UV systems, and question whether a more effective control mechanism might be required. Finally, we raise the possibility that, in the not too distant future, it may be possible to create and release fully autonomous UVs that can choose their own targets and use legal force without any human oversight at all. We question whether a form of international legal response might be necessary to stop us reaching that future without proper, informed public discussion about its risks and benefits.

1.1 Definition and Terms

We use several phrases throughout this article which we recognise are not universally accepted terms. We also recognise that the acronyms can become confusing, and have therefore set out the most commonly used terms below.

1.1.1 Common Acronyms, Synonyms and Key Terms

- UVs: Any vehicle which operates without a human in direct physical contact with that vehicle.
- UV variants: The four acronyms used to describe UVs operating in different environments are UAVs (unmanned aerial vehicles), UGVs (unmanned ground vehicles), USVs (unmanned [water] surface vehicles), and UUVs (unmanned underwater vehicles).
- UCV variants: Refers to weaponised UVs. UVs designed specifically for this purpose usually include the term 'combat' within the acronym; hence a UCAV is an unmanned combat aerial vehicle.
- Systems variants: Some authors prefer the term 'system' to vehicle – thus UAS rather than UAV – as it better reflects the complex network of onboard, remote and ancillary equipment required to operate the machines.[1] To avoid confusion we retain the more common term 'vehicle' for this article.

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1 P McBride, 'Beyond Orwell: The Application of Unmanned Aircraft Systems in Domestic Surveillance Operations' (2009) *Journal of Air Law and Commerce* 74, 629.

- Drones: The term 'drone' is arguably the most common and widespread synonym for UVs. In particular it is used to refer to unmanned aerial vehicles (UAVs).[2]

- Remote vehicles: Other common terms used to describe UVs include Remotely Piloted Vehicles and Remotely Operated Vehicles. These generally refer to vehicles over which a human has direct, albeit remote, control. For instance a human operator receives visual images from cameras or sensors onboard a UV and steers it by cable (tethered control) or wireless signal (remote control). This form of human/machine interface is referred to as 'teleoperated' control.

- Robotics: The more autonomous forms of UVs are often referred to as robots or robotic systems. The Oxford English Dictionary (OED) describes a robot as 'a machine … designed to function in place of a living agent, esp. one which carries out a variety of tasks automatically or with a minimum of external impulse'. Although we accept there is disagreement about this term,[3] we will maintain the OED definition for the purposes of this article.

1.1.2 Autonomy

UVs vary in their form and complexity, but perhaps the most important distinguishing feature, especially for the purposes of this article, is the degree to which a UV can operate without human control and direction.

Modern UVs are all 'controlled' to one degree or another; however modern technology platforms and 'artificial intelligence' (AI) give drones the capacity to function without direct human intervention. UAVs in current use can, for instance, be set general patrol coordinates and then left to pilot themselves; while surveillance UGVs can independently patrol long stretches of border, only alerting a human controller when suspicious activity is detected.

Due to this increasing level of independence, UVs are often referred to as 'autonomous vehicles'. However, it is clear that, at present, no drone in active military or commercial use is actually 'autonomous', in the sense that they are completely independent or self-governing. For the purposes of this paper, we will thus maintain a distinction between 'semi-autonomous' and 'fully autonomous' drones.

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2 Indeed, the Oxford English Dictionary describes a drone as 'a pilotless aircraft or missile directed by remote control.'

3 However, experts disagree as to when something actually can be described as a robot and when it is merely a machine. There is also disagreement as to the form and functions which such an entity may take on, for instance whether it can be completely software based or not: see Robin Murphy, *Introduction to AI Robotics* (2000) 3, 15–16.

Semi-autonomous drones are given broad operating instructions by operators, but are left to carry out routine functions within those parameters, such as navigation or monitoring operations, or even returning to base when fuel supplies are low. Critical decisions, such as whether to fire weapons or follow a suspect target off routine patrol paths are currently left to a human operator to veto or directly control. In this respect military officials sometimes describe this form of artificial intelligence as 'supervised autonomy'.[4]

Fully autonomous drones would not require such a human veto. Rather, they would be given general instructions and then left to fulfil their directives according to their programming and artificial intelligence. In this way a fully autonomous drone would be akin to a soldier who is given a general directive — for instance, 'secure that hill' — but, apart from observing general rules of engagement would be left to fulfil the mission according to programming.

2. *The Historical Use of Unmanned Vehicles*

As we stated above, unmanned vehicles are by no means a novel technology. Ancient civilisations are known to have built a variety of unmanned craft, even flying ones.[5] Although some of these may have simply been for science or spectacle, more often than not ancient UVs were used to provide advantage on the battlefield. In that arena, unmanned vehicles were seen as advantageous as they could, on the one hand, maximise the influence over the zone of conflict whilst, on the other hand, minimise exposure of personnel to the risks created by the conflict.[6] This trend continued into the

4 John Keller, *The time has come for military ground robots* (2010) 20(6) *Military & Aerospace Electronics* <http://www.militaryaerospace.com/index/display/article-display/363893/articles/military-aerospace-electronics/volume-20/issue-6/features/special-report/the-time-has-come-for-military-ground-robots.html> (accessed 10 March 2010).

5 The ancient Greek engineer Archytas is said to have invented the first UAV, a mechanical pigeon, in the 4th Century BC. It was recorded as having flown some 200 meters. Kimon P Valavanis, *Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy* (2007).

6 Hence, the vast majority of early R&D in unmanned vehicles was directed towards gathering surveillance from, or delivering payloads to, high-risk territory. The Greeks and Chinese, for instance, set unmanned ships on fire and steered them into their enemies' fleets to cause panic and destruction or break their formation. Chinese generals also made use of kites for military reconnaissance. In 200 BC, the Chinese General Han Hsin of the Han Dynasty was said to have flown a kite over the walls of a city he was attacking to measure how far his army would have to tunnel to reach past the defences. See Michael John Haddrick Taylor and David Mondey, *Milestones of Flight* (1983); Kenneth S Smith Jr, *The Intelligence Link – Unmanned Aerial Vehicles and*

mechanisation of war following industrial revolution; indeed some of the first machines to enter unto the modern battlefield were UVs.[7] Yet, despite being involved in most major armed conflicts from that period to the turn of the millennium,[8] the impact of on the conflict zone and the outcome UVs — with some notable exceptions by the Israelis[9] — was rather minimal.[10]

A number of factors might account for the sidelining of UVs from mainstream combat roles during the twentieth century. One is the

the Battlefield Commander (1990) GlobalSecurity.org Reports, <http://www.globalsecurity.org/intell/library/reports/1990/index.html> (accessed 2 March 2010).

7 Including unmanned surveillance balloons that dropped explosives on enemies (patented in 1863), remotely controlled torpedoes (1866) and aerial kites equipped with cameras remotely controlled by a long string to take surveillance photos of enemy positions and fortifications (1898).

8 See Office of the Secretary of Defense (US) *Unmanned Aircraft Systems Roadmap 2005 – 2030*, (2005) k-1, ('US OSD Roadmap').

9 During the 1980s the Israeli air force had successfully used UAVs to detect, and draw fire from, Syrian anti-aircraft batteries, allowing manned jets to then remove the threat. Following this success, Israel expanded its drone program, placing extensive resources into the novel technology and how it could be integrated into combat systems and strategy. By the turn of the century Israel was using a range of UVs to provide Intelligence, Surveillance and Reconnaissance (ISR) data from, or adjacent to dangerous enemy territory that could be provided via up-to-the-minute feeds to commanders, air support, battle units and strike teams. See Adam Stulberg, 'Managing the Unmanned Revolution in the U.S. Air Force' (2007) 51(2) *Orbis* 253.

10 Although the German V-1 bombs that terrorised London during the late part of WWII are often cited as the first successful UAV attack, we would not consider them either true UAVs in the modern sense, nor truly 'successful'. Whilst the technology behind V1s was, at the time, groundbreaking, it was not capable of providing a significant advantage over traditional, manned vehicles. In part this was because the systems were too costly to operate both in terms of real costs but also in terms of payload efficiency: only about one quarter of V1s were to hit their targets, with the remainder failing. V-1s are simply single use, single target 'terror weapons' which 'lacked precision guidance'. The guidance problems that plagued V-1s would also be a problem for postwar UAVs. These problems included; a … short duration aloft and communications limitations, which required a line-of-sight to the UV or at the least close proximity to it. Whilst this was acceptable in non-conflict arenas, for instance where the drones were used as test targets, the limitation undermined one of the main advantages of UV technology; that is, removing humans from the area of risk. See Bill Yenne, *Attack Of The Drones: A History Of Unmanned Aerial Combat* (2004) 19; see also, Daren Sorenson, *Preparing for the Long War: Transformation of UAVs in Force Structure Planning for Joint Close Air Support Operations* (2006) Joint Forces Staff College (US) 14–15, <http://en.scientificcommons.org/35201347> (accessed 12 March 2010).

lack of support by some operations planners and military commanders, due to the unproven, untested and initially unreliable technology.[11] Indeed, like many novel technologies the vision of UV proponents was often far in advance of what was actually achievable at the time.[12] This was particularly true of the use of UVs in combat or ground roles. Early UVs did however prove successful within aerospace reconnaissance, decoy and target roles;[13] which made them popular with the intelligence community. However, that meant that much of the research and development in the area was highly classified,[14] and as such it is hard to determine just the number of UVs deployed to conflicts and covert operations.[15]

2.1 Non Military Roles

UVs tended to have an even smaller role outside of the military. The main exceptions to this general rule were within exploratory UUVs and agricultural UAVs.

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11 As Goebel states: 'The whole idea of reconnaissance drones seemed to be completely dead, but at the last moment the USAF rescued the program. One of the interesting themes in defence programs is how new military systems are often initially proposed in grand terms, with whizzy features and the latest technology. When the grand plan proves too complicated and expensive, the military then backtracks, finally ending up with a much more modest solution, often a minimal modification of an existing system. Interestingly, such compromise solutions often prove far more effective than expected.' See Greg Goebel, *Unmanned Arerial Vehicles* (2010) Worldscapes, v1.6.0, ch 4 <http://www.vectorsite.net/twuav.html> (accessed 01 March 2010).

12 In particular limitations on computing processing power and communications meant that UVs were not suited to combat roles where complex decision-making and quick reactions were required. For this reason UGV development was also slower than UAV given the need for high order collision avoidance that was beyond the processing power of early computing processors. See generally, D W Gage, 'UGV History 101: A Brief History of Unmanned Ground Vehicle (UGV) Development Efforts' (1995) 13(3) *Unmanned Systems Magazine*.

13 Where they were not required to undertake complex navigation to avoid obstacles or hazards, and therefore did not require a large amount of command and control and therefore were less susceptible to jamming or spoofing. See Goebel, above n 11.

14 Although Newcome postulates that part of the reason that information about drone use in conflicts like the Vietnam War was suppressed was a fear that it would affect the livelihoods of human fighter pilots by creating a push towards the roboticisation of the air force. See Laurence Newcome, *Unmanned Aviation: A brief history of Unmanned Aerial Vehicles*, American Institute of Aeronautics and Astronautics (AIAA) (2004) 67–69.

15 UVs featured in conflicts such as the Vietnam war (see US OSD Roadmap, above n 8, p k-1) although it is clear that they did undertake important surveillance and decoy missions. See Newcome, ibid, 69.

The oceans are relatively uncluttered and do not require highly complex navigation which made early UUV development easier.[16] UUVs proved useful in undersea mapping, and later in wreck detection and submarine rescue.[17] Obviously these roles had a naval/military utility, yet they also were important for other sectors, particularly marine research and the resource industry. Despite such vehicles being unmanned during this period, the reality was that most commercial, research and military UUVs were 'tethered' to a human operator and could not truly be said to be semi-autonomous.[18]

Another exception to the military focus of UV development has been in aerial spraying of agricultural crops, in particular by the Japanese who trialled unmanned helicopters as early as the 1950s.[19] Again, these were more of a remote controlled vehicle rather than something that could be described as semi-autonomous. However, by the turn of the century Japanese rotary-wing UAVs were advanced enough to navigate to pre-programmed routes and within those confines undertake tasks such as crop spraying, agricultural monitoring or scientific mapping, without direct human oversight.[20] These systems proved very popular in that country, with thousands being used in civilian tasks. Indeed, until recently the most common use of a UV in Japan was for aerial spraying, rather than military or state operations.[21]

2.2 UVs in the 21st Century

The latter part of the 20th century saw the advent of the 'digital revolution', which resulted in dramatic advances in computing processing power, sensor technology and satellite

16 G N Roberts, 'Trends in Marine Control Systems' (2008) 32 *Annual Reviews in Control* 263.

17 Indeed UUVs — albeit tethered versions — gained a great deal of public attention during the 1990s with the discovery and exploration of undersea wrecks like the Titanic, the Lusitania, and the Bismarck, which could only have been made possible through robotic UV systems. In fact, the first 'golden age' in UV technology occurred under the oceans more than a decade before it did in the air. See Andrew Henderson, 'Murky Waters: The Legal Status of Unmanned Undersea Vehicles' (2006) 53 *Naval Law Review* 55, 57.

18 Roberts, above n 16, 266.

19 With commercial use starting in the 1970s. See Mark Peterson, 'The UAV and the Current and Future Regulatory Construct for Integration into the National Airspace System' (2006) 71 *Journal of Air Law and Commerce* 521, 546.

20 Ibid.

21 Ibid.

telecommunications.[22] These technical developments permitted a commensurate evolution in UV independence and autonomy and by the turn of the century, technology was sufficiently advanced to generate real interest in deploying UVs outside of covert military operations.[23] However, it was perhaps the terrorist attacks in September 2001 in the United States (US) that served as the most important catalyst for the adoption of UVs as a key counterinsurgency tool. Of particular note are the ability of UVs to provide global, persistent surveillance; reduce the sensor-to-shoot cycle; and undertake dull dirty and dangerous roles. These factors are discussed in greater detail below.

2.2.1 Catalysts for the UV Revolution: 'Global Persistent Surveillance'

The terrorist attacks on the US in 2001, led to the so-called 'war on terror', and a decisive shift in the military strategy of the US and its allies. As its name suggests, the war on terror is one waged against asymmetric opposition — usually small groups, or even individuals, who may be dispersed, highly mobile and located in remote locations about which the US, prior to 2001, held little reliable intelligence.[24] The US response to these challenges was, in part, a policy of 'global persistent surveillance.' US Secretary of Defense, Donald Rumsfeld, described this policy as one designed to 'deny enemies sanctuary by developing capabilities for persistent

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22 Satellite technology seems to have played a large part in drone development. Before reliable satellite imagery could be obtained, drones were attractive as low risk alternatives to manned fly-overs of risky territory. However, as satellite imagery became more reliable and of better resolution it was favoured over drones as a much less provocative way of collecting intelligence data. See Goebel, above n 11, ch 5. Other factors which contributed include: Central Processing Units aboard UVs were much more powerful and could effectively manage a wider range of functions that were previously required human oversight; Roboticisation and miniaturisation meant that previously manual controls could be handed over to the central processing unit; Digitisation and miniaturisation made for lighter, more efficient vehicles, which could be deployed for longer periods and over longer distances. The efficiency gains permitted a wider range of onboard sensors to be installed. Improvements in sensor technology allowed a much wider spectrum of visual and non-visual data to be collected at a higher resolution than before. Digital compression overcame previously detrimental information 'bottlenecks' and permitted much more of this data to be transmitted to the controller. For information on the 'digital revolution' see generally, Stephen Hoare, *Digital Revolution (20th Century Inventions)* (1998).

23 See Peter Van Blyenburg and Philip Butterworth-Hayes, 'UVS International Status Report on US UAV Programmes' in *2005 Year Book: UAVs Global Perspective* (2005) 112.

24 Anthony Cordesman, The Lessons of Afghanistan: War Fighting, Intelligence, and Force Transformation (2002) 26.

surveillance, tracking, and rapid engagement'.[25] This refocussing of US strategic and military policy shifted intelligence, surveillance and reconnaissance (ISR) operations from the periphery of covert operations to the centre of regular military engagements.[26] The result was increased demand, funding and research into platforms that could undertake consistent, wide-scale, and high-powered ISR duties.

2.2.2 Catalysts for the UV Revolution: Sensor to Shooter Cycle

A characteristic of the war on terror has been the disparity in logistical, technological and numeric strength between the US, and the armed groups opposing it. Those opponents have adopted an asymmetric response, involving the use of decentralisation, force dispersion, concealment, ambush techniques and the ability to quickly disappear into remote locations or, conversely, amongst civilian populations.[27]

Countering asymmetric warfare has required that conventional forces adopt a similar level of speed and versatility. In traditional warfare there is often a significant lapse between detecting and engaging an enemy, commonly referred to as the 'sensor-to-shooter cycle'.[28] Reducing the sensor-to-shooter cycle was a major concern for the conventional forces operating in the post 2001 middle-east conflicts. The longer the delay, the higher the chance the enemy would disappear into countryside or urban areas. Equally, the more time spent observing the zone to determine coordinates the higher the likelihood of surprise attack or ambush.[29]

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25 Quoted in ibid.

26 R Ackerman, 'Persistent Surveillance Comes into View' (2002) *Signal Magazine*, 18.

27 See, Steven Metz and Raymond Millen, I*nsurgency and Counterinsurgency in the 21st Century: Reconceptualizing Threat and Response* (2004) Strategic Studies Institute (SSI) monographs <http://handle.dtic.mil/100.2/ADA428628> (accessed 5 April 2010); Frank Hoffman, 'Complex Irregular Warfare: The Next Revolution in Military Affairs' (2006) 3(50) *Orbis* 395, 395–407; Mark Clodfelter 'Airpower versus Asymmetric Enemies – A Framework for Evaluating Effectiveness' (2002) 16(3) *Air and Space Power Journal* 37; Montgomery C Meigs, 'Unorthodox thoughts about asymmetric warfare' (2003) 33(2) *Parameters*, 5–6.

28 See Randal Bowdish, *Theater-Level Integrated Sensor-to-Shooter Capability and its Operational Implications* (1995) US Joint Military Operations Report <http://handle.dtic.mil/100.2/ADA293332> (accessed 5 April 2010).

29 This as especially true in war zones where insurgency forces had accessibility to and expertise in using small surface-to-air missiles. See Cordesman, above n 24, 30.

2.2.3 Catalysts for the UV Revolution: Dirty, Dull and Dangerous

The growth of UV technology has also been attributed to their propensity to undertake 'dull, dirty and dangerous' roles.[30] This has led them to become extremely popular amongst military and governmental planners and decision makers. This is not least because of the highly politicised nature of modern warfare and the belief amongst administrators and strategists that the public has a low tolerance for domestic troop casualties in foreign conflicts.[31] Furthermore, effective troop management and efficiency are extremely important in modern military operations, which have become increasingly focused upon 'winning the peace' after the initial 'shock and awe' tactics have moved resistance into the hills or into the cities of conflict zones.[32] That requires resources on the ground to, on the one hand, patrol civilian areas for threats and ordinance and, on the other increasing troop engagement with local populations to help build trust and support.[33] UVs transfer risk from soldier to robot, permitting commanders to transfer troops to vital human-centric roles.[34]

3. A Love Affair with a Predator

In the preceding section we identified some of the main catalysts that lead to the adoption of UVs in the 'war on terror'. The Predator UAV, which has been used from the outset of this conflict, provides a clear illustration of how the new political and military paradigms that have arisen as part of this war have fostered the UV revolution.

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30 US OSD Roadmap, above n 8, 2. See also, Gregory J Nardi, *Autonomy, Unmanned Ground Vehicles, and the U.S. Army: Preparing for the Future by Examining the Past* (2009) School of Advanced Military Studies United States Army Command and General Staff College Fort Leavenworth, Kansas 10, <http://handle.dtic.mil/100.2/ADA506181> (accessed 4 April 2010).

31 Despite almost constantly being engaged in one war or another, there is a perception among many western military powers that, since the Vietnam conflict, the public has a low tolerance for domestic troop casualties arising out of foreign conflicts. See Charles Levinson, 'Israeli Robots Remake Battlefield; Nation Forges Ahead in Deploying Unmanned Military Vehicles by Air, Sea and Land' *Wall Street Journal* (New York, NY) 13 January 2010, A10. Although whether this is actually the case has been questioned. See Christopher Gelpi, Peter D Feaver and Jason Riefler, 'Success Matters: Casualty Sensitivity and the War in Iraq' (2006) 3(30) *International Security* 7.

32 Sarah Kreps, 'Debating American Grand Strategy After Major War: American Grand Strategy after Iraq' (2009) 4(53) *Orbis* 629.

33 Ali A Jalali, 'Winning in Afghanistan' (2009) 39(1) *Parameters* 5.

34 See Nardi, above n 30, 10.

The Predator UAV is a lightweight turboprop propelled plane just over eight metres in length, first developed in the mid-1990s for the US Central Intelligence Agency (CIA).[35] Each Predator UAV operates as part of a cohesive and integrated weapons system, made up of four UAVs with onboard sensors, a ground control station and a satellite communication suite.[36] All parts of this weapons system can be packed for rapid deployment and transport to remote locations within a very short period of time, with human operators remaining in one location controlling UAVs in another remote location, often on another continent and in a different time zone. Like other UV systems, Predators also offer a highly flexible and customisable equipment platform. Removing the pilot from an aerial vehicle, creates about 2.3 metric tonne of extra carrying capacity,[37] freeing up space and weight which can be used to retrofit a wide range of sensors or specialised equipment to suit the task at hand.[38] Alternatively, they can also be fitted with weapons systems, the most popular of which is the Hellfire missile, a long-range, supersonic missile designed for 'precision'[39] attacks on heavy armour.[40]

Outside of covert operations, the Predator had only been used sparingly, in part as a result of latency issues and a lack of integration with mainstream military forces.[41] However, by 2001 communications problems were largely overcome and it became apparent that the CIA was already using a small number of Predator

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35 The Predator was developed for the CIA by General Atomics Aeronautical Systems and is based on earlier Israeli UAV systems. See Bill Yenne, *Attack Of The Drones: A History Of Unmanned Aerial Combat* (2004) 56-57. For information on the Predator UAV see US OSD Roadmap, above n 8, 4. See also Bill Gunston, 'Unmanned Aircraft – Defence Applications of the RPV' (1973) 4(188) *Royal United Services Institute for Defense Studies Journal* 41.

36 It is for this reason that predator and similar drone systems are often referred to as Unmanned Aerial Systems or (UAS). See R J Newman, 'The Little Predator That Could' (2002) 3(85) *Air Force Magazine* 48.

37 This is because, not only is the pilot no longer on board, there is no longer the need for a cockpit, ejector seats, atmospheric protections, controls. Indeed removing the pilot also renders much of the armor required to protect a human occupant redundant. See Gunston, above n 35.

38 For instance, Predator drones undertaking ISR duties carry a large range of sensor equipment including high-powered colour and night vision equipped cameras, infra-red and heat sensors. See Newman, above n 36, 51.

39 Even though this term is used it is well accepted that, whilst the targeting may be precise the Hellfire's collateral damage may not be. See Roy Braybrook, 'Strike Drones: Persistent, Precise and Plausible' (2009) 4(33) *Armada International* 21.

40 Ibid.

41 Ibid.

drones to covertly search for Osama Bin Laden in Afghanistan.[42] As a result, Predator UAVs were already deployed to the region at the outbreak of hostilities following the terrorist attacks in September 2001.[43] From October that year Predators were flying ISR missions, and in February 2002, the Predator undertook its first operational strike, armed with hellfire missiles.

In the wake of these initial sorties, analysts lauded the Predator as a panacea for the special operating conditions required by the war on terror.[44] What was most exciting for military planners was its ability to pass real-time ISR data to strike teams and decision makers, located both inside and outside of the conflict zone. Predators solve much of the 'sensor-to-shooter cycle' problems in the insurgent focused Afghan and Iraq conflicts by providing live surveillance feeds to combat teams that are able to engage with the target instantly.[45]

Newman wrote at the time that the,

> Predator was an instant hit because it could transmit live video footage of enemy actions to commanders on the ground and aircrews above the battlefield. It illuminated targets for precision weapons fired from afar. It even, on occasion, fired its own weapons, a rarity for a UAV.[46]

In addition to the aforementioned benefits of UVs, the versatility of the predator platform and its transportability have also been credited with its rapid adoption and expansion post 2001. Predators, like other UAVS, are also extremely inexpensive to operate in comparison to conventional manned equivalents.[47] Furthermore, they act as 'force multipliers', allowing soldiers and operatives to have a much wider view of the battlefield than they would have previously had.[48] They also reduce soldiers' workloads, allowing

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42 Ibid.

43 Ibid.

44 Newman, above n 36, 48; Cordesman, above n 24, 62-63; Stulberg, above n 9, 251.

45 Cordesman, above n 24, 60-61.

46 Newman, above n 36, 48.

47 United States Air Force, U*nmanned Aircraft Systems Flight Plan 2009-2047* (2009) <http://www.fas.org/irp/program/collect/uav.htm> (accessed 1 February 2010) ('US Flight Plan').

48 *Eyes of the Army: U.S. Army Roadmap for UAS 2010-2035* (2010) U.S. Army UAS Center of Excellence, Report no ATZQ-CDI-C, 72 <http://www.fas.org/irp/program/collect/uas-army.pdf> (accessed 20 March 2010) ('US Army Roadmap').

troop energies to be directed towards critical areas that still require active human involvement.[49]

3.1 An Expanding Aerial Presence – From Sideline Support to Central Strategy

Military advances, especially by technology rich superpowers like the US are driven by a consistent belief that scientific and industrial progress will guarantee both military supremacy and success at war.[50] This was particularly true of the Predator UAV. Despite continuing caution by some military strategists, the Bush Administration made funding of these high tech weapons a 'top priority' in its 2003 budget.[51] Government spending on drone programmes has increased ever since, with the most recent Obama Administration expected to spend $5.4 Billion on unmanned military technologies in 2010.[52] The result has been a marked increase in the number[53] and type of UVs used on the battlefield by the US, and a revolutionary shift in the focus of modern military operations.

As Stulberg writes, '[i]t is now conventional wisdom that we stand at the dawning of the unmanned aerial vehicle (UAV) revolution in military affairs.'[54] From 2003 to 2008, UAV flights increased by 2,300 percent. Prior to 2001, the Department Defence had less than 50 UAVs; by 2006 the number was well over 3,000,[55] and now stands at

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49 The US Army views UAS' success in its ability to 'significantly augment mission accomplishment by reducing a Soldier's workload and their exposure to direct enemy contact. The UAS serve as unique tools for the commander, which broaden battlefield situational awareness and ability to see, target, and destroy the enemy by providing actionable intelligence to the lowest tactical levels.' See US Army Roadmap, ibid, 1.

50 See Jack Beard, 'Law and War in the Virtual Era' (2009) 103(3) *American Journal of International Law* 409, 412.

51 Newman, above n 36, 58.

52 'Pentagon's unmanned systems spending Tops $5.4 billion in FY2010' *Defence Update* (online) 14 June 2009 <http://defense-update.com/newscast/0609/news/pentagon_uas_140609.html> (accessed 5 April 2010).

53 Alan Brown, 'The Drone Warriors' *Mechanical Engineering Magazine* (online) January 2010 <http://memagazine.asme.org/Articles/2010/January/> (accessed 1 March 2010).

54 Stulberg, above n 9, 251.

55 United States Government Accountability Office, *Unmanned Aircraft Systems: Improved Planning and Acquisition Strategies Can Help Address Operational Challenges* (Testimony Before the Subcommittee on Tactical Air and Land Forces, Committee on Armed Services, House of Representatives, 6 April 2006) 5.

more than 7,000.[56] Last year (2009) the US Air Force trained more UAV operators than conventional pilots, reflecting the new direction of aerial warfare.[57]

4. *Current Aerial Applications*

Modern UAVs can basically be separated out into three main classes:[58] micro and small; medium altitude; and high altitude, long endurance (HALE).[59]

Micro and small UAVs are typically less than a metre in length, while Micro UAVs are measured in centimetres. Launch is usually by hand or by catapult, with the drone flying at low altitudes and limited ranges.[60] They are usually battery powered and therefore very quiet.[61] Small and mico UAVs are most commonly used by ground units to provide short-range, up to the minute ISR data.[62] They are also favoured by intelligence bodies such as the CIA.[63] Whilst this class is currently restricted to largely ISR roles 'the Army

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56 Levinson, above n 31.

57 Ibid.

58 S A Kaiser, 'Legal Aspects of Unmanned Aerial Vehicles' (2006) 55(3) *Zeitschrift Fur Luft-Und Weltraum-Recht* 344, 345-346.

59 An informative list can be found at the US Flight Plan website, see above, n 47. A more comprehensive overview can be found at the Goebel Public Domain review of UAVs, see Goebel, above n 11.

60 Although some of the micro rotary wing vehicles can take off of their own accord, and some micro UVs have been developed which can 'cling' to the sides of building then release themselves into flight. See Alexis Desbiens and Mark Cutkosky, 'Landing and Perching on Vertical Surfaces with Microspines for Small Unmanned Air Vehicles' (2009) 57 *Journal of Intelligent and Robotic Systems* 131.

61 James F Abatti, *Small Power: The Role of Micro and Small UAVs in the Future* (2005) Air Command and Staff College, 184.

62 For instance, the RQ-11 Raven can be stored in a backpack, is launched into the air by hand to allow troops in the field to 'see over the next hill' which could be over 10 kilometres away. See AeroVironment Inc, 'AeroVironment Receives $37.9 Million In Orders For Digital Raven UAS, Digital Retrofit Kits' (Press Release, 23 February 2010); AeroVironment Inc, 'War on Terrorism Boosts Deployment of Mini-UAVs' (Press Release, 08 July 2002). Both press releases are available at <http://www.avinc.com/resources/press_room/> (accessed 15 April 2010).

63 The CIA have reportedly used ultra-quiet micro-drones, 'roughly the size of a pizza platter [that] are capable of monitoring potential targets at close range, for hours or days at a stretch. See Joby Warrick and Peter Finn, 'Amid outrage over civilian deaths in Pakistan, CIA turns to smaller missiles', *Washington Post* (Washington DC) 26 April 2010, A8.

has begun to actively pursue offensive capabilities for its small UAVs.'[64]

Medium Altitude UAVs generally operate at the same altitudes as conventional commercial aircraft.[65] The Predator is a medium altitude UAV, but is now joined by a wide spectrum of flying vehicles.[66] A second generation Predator B, for instance — also known as the 'Reaper' — is capable of reaching altitudes of 15.8 kilometers and can fly up to 36 hours before refuelling.[67] It has also been designed to provide a much more combat focused platform (spawning the term 'Unmanned Combat Aerial Vehicle' UCAV), and can now carry laser guided bombs, Hellfire air-to-ground missiles, munitions and soon an air-to-air missile system.[68] Two turbo-fan variants of the Predator have also been designed. The 'Mariner', a maritime version of the Predator that has been adapted to fly even longer ranges for naval surveillance as well as take-off and land from seaborn vessels,[69] as well as a stealth focussed, turbo-prop Predator variant (the Predator C 'Avenger').[70]

A range of rotary wing vessels in this class are also in development or in active use, for surveillance and targeting with weaponised versions close to being deployed. The MQ-8B, for instance, is an unmanned helicopter system, able to be launched from ocean going platforms travelling at speeds of 200 kilometres per hour at up to 6,000 metres for up to eight hours without refuelling. It is able to fire a range of mountain missiles and rockets and carries day/night and multispectral sensors with targeting lasers for strikes by larger aerial vehicles.[71]

High Altitude and Long Endurace (HALE) UAVs fly at altitudes over nine kilometres and are designed for wide area, long-term

64 Abatti, above n 61.

65 Kaiser, above n 58, 345.

66 See US OSD Roadmap, above n 8, 3–13.

67 Which can be undertaken in the air. The Reaper is also able to be fitted with additional fuel tanks, allowing a fully laden drone (including hundreds of kilos of munitions) to stay aloft for up to two days. See Goebel, above n 11.

68 The 4763-kg Reaper is cleared not only for Hellfire but also for the much heavier GBU-12 Paveway II, GBU-38 Jdam and GBU-49 Enhanced Paveway II, based on 227-kg (class) warheads. See Braybrook, above n 39.

69 'Ocean-Going Drones' (2006) 12(165) *Aviation Week & Space Technology* 56.

70 It internalises all storage and weapons bays and is designed to avoid visual and radar detection. The Avenger is also favoured by the Navy given its rear turbofan propulsion system is much safer in naval scenarios. See Goebel, above n 11.

71 US OSD Roadmap, above n 8, 9.

surveillance. Typically they can stay aloft for long periods of time, providing ISR data over an extremely large target area. Given the highly covert nature of the high altitude spy drones they tend to be highly classified and shrouded in mystery.[72] One exception is the Northrop Grumman Global Hawk, which can reach altitudes exceeding 19 kilometres.[73] Operating at this altitude provides the craft with a surveillance range of over 100,000 square kilometres via high-powered sensors, which can see through clouds, darkness and dust.[74] One military strategist described them as being 'like a low Earth orbit satellite that's present all the time.'[75] The additional advantage of operating at high altitude is that the fighter-jet sized UAV is far outside the range of most air defence systems, allowing relatively low risk and constant ISR surveillance. This also frees up human operators from the need to constantly monitor for ground-based threats.

4.1 UCAVs

Whilst UAVs began primarily as surveillance craft, they are increasingly used for combat roles. Whilst originally this involved retrofitting UAVs with weapons systems a large amount of effort is now going into creating combat specific UCAVs.[76] Facilitating this transition are a range of lightweight missile systems currently in development. These lighter payloads will allow for the weight gains to be put towards improving the engines, armour or stealth capabilities of the drones.[77] Since the outset of the war in Afghanistan in 2001, the number of UCAVs in use, as well as the situations in which they have been used, has grown exponentially. A New York Times article, citing figures released by the US Air Force, stated that Predators and Reapers have fired at least 184 missiles and 66 laser-guided bombs at 'militant suspects' in Afghanistan since the

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72 In 2007 for instance, a UAV resembling a sleek stealth bomber — minus the cockpit — was observed in Khandahar, and subsequently referred to as the 'Beast of Kandahar'. Last year the US Air force confirmed that the UAV was in fact an 'RQ-170 Sentinel' tactical surveillance platform. No further information has been provided about the UAV. See Goebel, above n 11.

73 The record is 19,928 meters). See, *UAV World Records*, <http://records.fai.org/uav/aircraft.asp?id=2151> (accessed 18 March 2010).

74 That means that only five Global Hawks are required to provide high altitude ISR for the whole of the Afghan landmass (and of those, only three need to be aloft at one time).

75 Newman, above n 36, 52.

76 Braybrook, above n 39.

77 Lightweight air-to-surface missiles now under development will open the ground-attack role to far greater numbers of drone platforms. This in turn will pave the way for heavier, stealthy, dedicated unmanned combat air vehicles (UCAVs). See Braybrook, ibid.

start of 2009.[78] Although much of the shift towards combat specific UAVs has been led by the US, a number of other countries are now designing and commissioning UCAVs.[79]

5. *A Move to the Ground*

Whilst UVs have become the centrepiece of modern air warfare, UGVs have a much more complex operating and navigational environment. That is not to say that UGVs are not in use by the armed forces; in fact, more ground robots (12,000 in total) are used in Afghanistan and Iraq than UAVs (approximately 7,000). However, the majority of these are remotely controlled or 'teleoperated'[80] and not semi-autonomous.[81]

Teleoperated UGVs are used in a wide variety of situations which pose immediate risks to human combatants; in particular ordinance disposal, urban scouting, and doorway breaching.[82] Small UGVs can also be fitted with a variety of cameras and sensors to see through smoke, at night or detect the existence of explosives, chemical, biological or radiological agents.[83] A weaponised teleoperated UGV,[84] the Special Weapons Observation Remote Direct-Action

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78 Christopher Drew, 'Drones Are Playing a Growing Role in Afghanistan' *The New York Times* (online) 19 February 2010, <http://www.nytimes.com/2010/02/20/world/asia/20drones.html> (accessed 15 March 2010).

79 See, Robert Wall and Douglas Barrie, 'European UCAVs Take Shape' *Aviation Week & Space Technology* (online) 13 July 2008, <http://www.aviationweek.com/aw/generic/story_generic.jsp?&id=news/aw071408p1.xml> (accessed 12 April 2010); 'nEUROn UCAV Project Rolling Down the Runway', *Defence Industry Daily* (online) 21 January 2009, <http://www.defenseindustrydaily.com/neuron-ucav-project-rolling-down-the-runway-updated-01880/> (accessed 12 April 2010); Alexey Komarov and Douglas Barrie, 'First Look at MiG Skat UCAV', *Aviation Week & Space Technology* (online) 24 August 2007, <http://www.aviationweek.com/aw/generic/story.jsp?id=news/MIG082307.xml&channel=null> (accessed 12 April 2010); Nicolas von Kospoth, *China's Leap in Unmanned Aircraft Development* (14 October 2009) *Defpro.focus* <http://www.defpro.com/daily/details/424/> (accessed 12 April 2010).

80 See definition section above. Teleoperated UGVs are controlled much in the same way as a remote control toy car, with a human operating the vehicle a short distance away, either by sight or via onboard cameras.

81 The most common role for teleoperated UGVs in contemporary conflicts is in the neutralisation of improvised explosive devices. US OSD Roadmap, above n 8, 19.

82 Levinson, above n 31.

83 Nardi, above n 30, 40.

84 SWORDS can be fitted with a range of high velocity, sniper, or machine guns or even rocket launchers. See Stew Magnuson, 'Armed

System (SWORDS) was approved for use in Iraq in 2008.[85] SWORDS are nearly silent to operate and can move as fast as a running person, climb stairs and rock piles, move through wire barriers, sand, snow and water and correct themselves if knocked over.[86]

Larger teleoperated vehicles have been designed to rescue and provide first aid to injured troops under fire, 'with minimal intervention by medic or other first responder operators.'[87] Others have been developed for repair and reconstruction under fire, such as moving dirt or repairing craters in runways.[88]

Whilst the majority of UGVs are currently teleoperated, there is a concerted effort to field more autonomous vehicles, which do not require constant human oversight and control. Autonomous or semi-autonomous land based navigation is perhaps the most challenging of the environments for UV programmers and engineers due to the plethora of 'nontrivial navigational capabilities' required to effectively operate in ground roles.[89] However, the Israelis have made significant inroads integrating autonomous UGVs into active military practice.[90] The Guardium UGV for instance is a small armoured all terrain vehicle equipped with a wide array of cameras and sensors. It can patrol to pre-programmed coordinates without human control and react to unscheduled events.[91] It was deployed

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Robots Sidelined in Iraqi Fight', *National Defence Magazine* (online) May 2008, <http://www.nationaldefensemagazine.org/archive/2008/May/Pages/Armed2265.aspx?PF=1> (accessed 15 April 2010).

85 Ibid. However, it is unclear whether the unit has been used or not, as some concerns were raised about the UGVs reliability.

86 K Jones, 'Special Weapons Observation Remote recon Direct Action System (SWORDS)' in *Platform Innovations and System Integration for Unmanned Air, Land and Sea Vehicles* (Paper 36, Meeting Proceedings, AVT-SCI Joint Symposium) 36–1, 36–8.

87 Katie Drummond, 'Pentagon Seeks Robo-EMS to Rescue Wounded Warriors', *Wired* (online) 3 March 2010, <http://www.wired.com/dangerroom/2010/03/pentagon-seeks-robo-ems-to-rescue-wounded-warriors/#more-22983> (accessed 2 April 2010).

88 See Gage, above n 12, 2.

89 In this respect both Russian and American space exploration programs have provided major advances to artificial intelligence systems. Indeed, the Russians, unable to afford manned moon exploration, instead placed resources into UVs, placing them at forefront of UGV development until quite recently. See Gage, above n 12, 6.

90 This can be attributed to the fact that there is an ongoing state of war in that country combined with a low tolerance for casualties amongst the populace.

91 It does so, 'in line with a set of guidelines specifically programmed for the site characteristics and security routines'. See the Manufacturer

on the Israeli border to detect infiltrators after humans undertaking the same roles were attacked and kidnapped in 2006.[92] A weaponised combat version of the Guardium has been trialled and certified by the Israeli army.[93]

South Korea is reportedly using a similar UGV to the Guardium to patrol its border with North Korea.[94] South Korea also operates stationary robotic platforms that can detect, identify and target intruders in a completely autonomous way, if permitted.[95]

In the US, there has been a concerted effort by the Administration to bring UGV autonomy up to the level of UAVs and indeed provide for more autonomous and complex AI in the future.[96] Currently, the US is trialling a number of medium to large UGV systems.[97] These include: the Black-I Robotics unmanned crossover land vehicle, similar in weight and specifications to the Guardium UGV;[98] a larger, truck sized, Multifunction Utility Logistics Equipment (MULE) UGV designed mostly for transport and operations support;[99] and heavier six-ton UGV tank code-named the 'Crusher' for heavy payloads and rugged terrain.[100] The Crusher can operate in semi-autonomous mode, or be remotely teleoperated by satellite link.[101]

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website for the Guardium, <http://w*ww.g-nius.co.il/unmanned-ground-systems/guardium-ugv.html*> (accessed 12 April 2010).

92 Levinson, above n 31.

93 It can carry over 1000 kilos of weapons and munitions. See GENIUS Unmanned Ground Systems (2010) <http://g-nius.co.il/unmanned-ground-systems/avantguard.html> (last accessed 12 April 2010).

94 See Brown, above n 53.

95 Ronald C Arkin, *Governing Lethal Behavior: Embedding Ethics in a Hybrid Deliberative/Reactive Robot Architecture* (2007) Georgia Institute of Technology, 5.

96 National Research Council (US), *Technology Development for Army Unmanned Ground Vehicles*, (2002) 1-12.

97 Office of the Secretary of Defense (US), *Unmanned Systems Integrated Roadmap*, (2009) Report no FY2009–2034, 111-134 ('Integrated Roadmap').

98 Although it is also designed to undertake perimeter patrols and surveillance, the US is currently focusing much of their UGV deployment strategy on gear transport for ground units. The Black-I Robotics UGV is designed to carry packs, food, water, and ammunition for light infantry forces, which it will follow automatically through a range of terrains for up to eight-hour shifts before refueling. See Black-I Robotics , <http://www.blackirobotics.com> (accessed 14 May 2010).

99 Integrated Roadmap, above n 97, 116.

100 Ibid, 118.

101 Ibid.

6. *On and under Water: Naval UVs*

6.1 Surface Vehicles

Unmanned surface vehicles (USVs) are arguably the least developed of the UV family, despite the fact that the surface of the water — at least calm water — is perhaps the most easily navigable environment for a robotic AI. Indeed, robotic technology is sufficiently advanced that UV systems can be retrofitted to (up to fifteen per control unit) conventional watercraft to provide them with semi-autonomous functions.[102] There have been recent forays into semi-autonomous UAVs however. The Israeli Protector is a nine metre sealed, rigid hull USV,[103] designed to protect against seaborn terrorist attacks.[104] It operates a water jet engine, allowing it to travel at speeds of 50 knots and can patrol in semi-autonomous mode; although its stabilised machine guns are currently teleoperated by a human controller, as is its public address system.[105] It is now in full service by the Israeli Navy.[106]

102 The UAPS20 is an 'Unmanned Autopilot System' designed by an Italian company, SIEL, which can be fitted to a rigid-hulled inflatable boat to turn it into a low cost USV that can undertake relatively complex waypoint navigation as well as teleoperated control. Up to fifteen boats can simultaneously be controlled for a wide range of tasks, from harbor patrol and surveillance, to ordinance countermeasures and even as a UAV or UUV launch platform. See SIEL, <http://www.sielnet.com/index.php/products/usv> (accessed 20 April 2010). The company also cites the possibility of using the system for 'naval targets' but does not provide any further information on how this may work, quite possibly because the most obvious weaponised use of the system would be as a boat-bomb.

103 See RAFAEL, <http://www.rafael.co.il/Marketing/358-1037-en/Marketing.aspx> (accessed 12 March 2010).

104 Such as the use of an explosive laden motorboat against the USS Cole in 2000. See Erik Sofge 'Robot Boats Hunt High-Tech Pirates on the High-Speed Seas' *Popular Mechanics* (online) 1 October 2009, <http://www.popularmechanics.com/technology/engineering/robots/4229443> (accessed 12 March 2010).

105 S J Corfield and J M Young, 'Unmanned surface vehicles – game changing technology for naval operations' in G N Roberts and Robert Sutton (eds), *Advances in Unmanned Marine Vehicles* (2006) IEE Control Series, 313.

106 Which operates it in a semi-autonomous manner to patrol harbors, gather ISR, laying and remove ordinance and engage in electronic warfare. See Matthew Graham, *Unmanned Surface Vehicles: An Operational Commander's Tool for Maritime Security* (2008) Joint Military Operations Department, Naval War College, 10 <http://handle.dtic.mil/100.2/ADA494165> (accessed 20 April 2010).

While the US has shown some interest in small patrol USVs,[107] it appears to have set its sights on developing much larger USV platforms. In 2010, DARPA launched the Continuous Trail Unmanned Vessel (ACTUV) program.[108] The project seeks to develop a frigate sized USV 'for theatre or global independent deployment' capable of tracking modern diesel electric submarines. DARPA hopes for a highly autonomous vessel 'founded on the assumption that no person steps aboard at any point in its operating cycle.' Communications with base are to be 'intermittent' for the 'global, months long deployments with no underway human maintenance or repair opportunity.'[109]

6.2 Underwater Vehicles

More prominent, both in military and civilian use, are USVs' undersea cousins, UUVs. Ordinance clearing UUVs were deployed by the allies in the early part of the second Iraq war to clear naval mines.[110] As a result a number of navies have fitted destroyer fleets with permanent onboard UUVs.[111]

In 2004, the US Navy mapped a twenty-year 'UUV Master Plan' that would substantially integrate UUVs into all aspects of its operations.[112] The UUV Master Plan envisions UUVs being used for a wide range of undersea operations,[113] to the extent that current manned undersea vehicles may become redundant or extremely

107 See Sofge, above n 104.

108 Defense Advanced Research Projects Agency, *ASW Continuous Trail Unmanned Vessel (ACTUV) Phase 1*, (2010) <https://www.fbo.gov/spg/ODA/DARPA/CMO/DARPA-BAA-10-43/listing.html> (accessed 20 April 2010).

109 Ibid.

110 During 2003, Australian, British and US UUVs cleared over 2.5 million square meters of the Iraqi coast of mines. Global Security Org, *Intelligence Collection Programs and Systems* (14 May 2008) <http://www.globalsecurity.org/intell/systems/uuv.htm> (accessed 20 April 2010).

111 Including the US and the UK in 2004. See 'Unmanned Remote Minehunting System Installed for USS Momsen Commissioning' *Space Daily* (online) 31 August 2004, <http://www.spacedaily.com/news/uav-04zzo.html>. Nicolas von Kospoth, *Royal Navy Introduces New Reconnaissance UUV* (24 February 2010) Defpro.focus <http://www.defpro.com/daily/details/515/> (accessed 12 April 2010).

112 Department of Navy (US), *The Navy Unmanned Undersea Vehicle (UUV) Master Plan* (9 November 2004) United States Navy Report <http://www.navy.mil/navydata/technology/uuvmp.pdf> (accessed 12 April 2010) ('UUV Master Plan').

113 Based on four pillars 'Force Net, Sea Shield, Sea Strike, and Sea Base'. See Henderson, above n 17, 57.

limited in future conflicts. These include: ISR collection and distribution; undersea mapping; the creation of moveable naval data and communications networks; countermeasure and decoy operations; and 'time critical strike capabilities against undersea, surface, air and land targets.[114]

7. *New Recruits, New Troops and New Military Paradigms*

As we have illustrated above, the rapid development of UV technology was primarily driven by perceived military needs. This section will thus seek to provide an overview of some of the legal issues arising from the use of UV technology, primarily drones, in the military context. The first major hurdle that confronts such an analysis is often however, the question of which legal regime is applicable. One of the earliest drone strikes carried out by the US in Yemen in 2001, illustrates this point. In this oft-cited incident, six men were travelling along a highway near Marib, when a CIA Predator drone strike destroyed the car, killing all six men inside.[115] The target of the strike was reportedly Ali Qaed Sunuan al-Harathi a 'high ranking militant' wanted by the US,[116] and Ahmed Hijazi, a US citizen and suspected al Qaeda member. The identities of the other four men have remained unknown, although they have been described as 'important terrorists' or al Qaeda operatives or suspects.[117] As is its tendency, the CIA never officially acknowledged that it was responsible for the attack.[118]

This strike has variously been characterised as an illegal use of force; a legitimate act of self-defence; and a legitimate act of war occurring as part of an armed conflict. O'Connell has argued that such strikes are nothing more than a law enforcement activity, and thus subject

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114 UUV Master Plan, above n 112.

115 See eg, Keith Somerville, 'US drones take combat role' *BBC News* (online) 5 November 2002, <http://news.bbc.co.uk/2/hi/2404425.stm> (accessed 15 February 2010).

116 Hijazi was allegedly involved in the planning of a bomb attack against the USS. Cole in the port of Aden in 2000. See Mary O'Connell, 'Unlawful Killing with Combat Drones: A Case Study of Pakistan, 2004-2009' (Research Paper No. 09-43, Notre Dame Law School Legal Studies, 2009) in Simon Bronitt (ed), *Shooting To Kill: The Law Governing Lethal Force In Context*, Forthcoming.

117 Heinz Klug, 'The Rule of Law, War, or Terror', (2003) (2) *Wisconsin Law Review* 365, 378.

118 Richard Murphy and A John Radsan, 'Due Process and Targeted Killings of Terrorists', (Research Paper No. 114, William Mitchell College of Law Legal Studies, 2009).

to international human rights law.[119] Similarly, UN human rights investigator, Philip Alston, considers that drone strikes constitute extrajudicial executions and are thus in violation of international law.[120] Indeed, the lack of consensus over the appropriate legal regime was alluded to by the Swedish Foreign Minister, Anna Lindh, when she said,

> [i]f the USA is behind this with Yemen's consent, it is nevertheless a summary execution that violates human rights. If the USA has conducted the attack without Yemen's permission it is even worse. Then it is a question of unauthorised use of force.[121]

Clearly, the circumstances in which such a strike can legally be carried out, the precautions that must be undertaken prior to the act, and the legal consequences of the act differ dramatically depending on the forum of law chosen. The determination of this question is particularly important given that the abovementioned strike is far from an isolated incident. Rather, it occurred in the context of a widespread program of targeted killings by the US.[122] That program relies almost entirely on UCAV drones; indeed it is arguable it exists because of UCAV technology, insofar as many of their inherent characteristics lend themselves to this form of engagement.[123] As a result, drones are used widely for the lethal engagement of suspected terrorists in a range of countries, including Iraq, Afghanistan, Pakistan and Yemen.[124] Whilst there is unquestionably an armed conflict in Iraq and Afghanistan, and perhaps Pakistan, there is arguably no armed conflict in Yemen. This partly explains

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119 Mary O'Connell, above n 116. See also David E Anderson, *Drones and the Ethics of War*, (May 14 2010) Religion and Ethics Newsweekly http://www.pbs.org/wnet/religionandethics/episodes/by-topic/middle-east/drones-and-the-ethics-of-war/6290/ (accessed 16 May 2010).

120 'US warned on deadly drone strike' *BBC News* (online) 28 October 2009, <http://news.bbc.co.uk/2/hi/8329412.stm> (accessed 12 April 2010).

121 Klug, above n 117, 380.

122 'Targeted killing' is the term used to refer to 'extra-judicial, premeditated killing by a state of a specifically identified person not in its custody.' See Murphy and Radsan, above n 118.

123 The theory behind this policy is that by repeatedly 'decapitating' terrorist groups by targeting their leaders and technical experts, eventually only replacements 'from the shallowest end of the talent pool' will remain, that 'will be ineffective and easy to defeat'. See Noel Sharkey, 'Death strikes from the sky: the calculus of proportionality' (2009) 28(1) *IEEE Technology and Society Magazine* 17.

124 Ibid.

why the use of drones in a program of targeted killing has generated both academic and political debate.[125]

7.1 Use of Force

When analysing the legal implications of UV technology in a military context, it is often difficult to separate the legal consequences of drone technology *itself,* from what it is primarily used for — in this case targeted killings in the war on terror. The US drone strikes in Yemen and Pakistan are well-publicised examples of this conundrum.

The prohibition on the use of force in international relations is contained in the United Nations Charter,[126] as is the right of self-defence.[127] As Lindh alluded above, a drone strike carried out in another state, with that state's permission, is not necessarily an illegal use of force. However, assuming for arguments sake that the permission of the 'targeted' state has not been forthcoming,[128] a number of legal issues are raised in this area of law. First, if the strike is carried out against individuals of an international terrorist organisation, is the strike 'against' another state, and thus contrary to the UN Charter? Similarly, it is debateable whether a state could respond in self-defence to an attack carried out by such an organisation, by targeting members of the organisation in one or more states.[129]

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125 See for instance, Chris Downes, 'Targeted killings in an age of terror: the legality of the Yemen strike' (2004) 9(2) *Journal of Conflict and Security Law* 277; Jordan J Paust, 'Self-defence targetings of non-state actors and permissibility of U.S. use drones in Pakistan' (2010) 19 *Journal of Transnational Law and Policy*; Laurie Calhoun, 'The Strange Case of Summary Execution by Predator Drone' (203) 15(3) *Peace Review* 209; Mary O'Connell, 'To kill or capture suspects in the global war on terror' (2003) 35 *Case Western Reserve International Law Journal* 325; Norman J Printer, 'The use of force against non-state actors under international law: an analysis of the U.S. predator strike in Yemen' (2003) 8 *UCLA Journal of International Law and Foreign Affairs* 331; Murphy and Radsan, above n 118.

126 *Charter of the United Nations*, Article 2(4).

127 *Charter of the United Nations*, Article 51.

128 As was the official position of Pakistan when US drone strikes commenced. See O'Connell, above n 116.

129 In *Legal Consequences of the Construction of a Wall in the Occupied Palestinian Territory* (*Advisory Opinion*) [2004] ICJ Rep, [139] (the 'Israeli Wall' case) the ICJ held that self-defence requires an attack from a state, not a non-state group.

7.1.1 International Humanitarian Law

International humanitarian law (IHL), also known as the laws of armed conflict, is a set of rules that centre upon limiting the effects of armed conflict. It aims to protect persons who are not or no longer participating in hostilities, and restricts the means and methods of warfare that may be employed.[130] IHL applies only in cases of armed conflict, whether international or non-international.[131] The following section seeks to provide an overview of some of the main challenges that UV technology poses to IHL.

The concept of armed conflict:

As the above discussion demonstrates, it is increasingly difficult to determine the threshold issue of whether IHL actually applies to the use of drones, that is, whether they are being used as part of an armed conflict.[132] Indeed, the advent of drones and the 'war on terror' have combined to challenge the concept of an 'armed conflict'. In particular, they have raised the question of whether a war can be fought globally against a non-state actor, and whether IHL does, or should, thus apply to each isolated incident in that conflict — such as the 2001 strike in Yemen. As the aforementioned comments illustrate, there is little academic agreement on whether IHL applies to such strikes.

It is noteworthy in this respect that the International Committee of the Red Cross (ICRC) disputes the existence of a 'global war' and considers that IHL is only applicable when a particular situation of violence reaches the threshold of armed conflict.[133] This is because

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130 See, *What is International Humanitarian Law?* (2004) International Committee of the Red Cross Advisory Service of Humanitarian Law <http://www.icrc.org/Web/eng/siteeng0.nsf/htmlall/humanitarian-law-factsheet/$File/What_is_IHL.pdf> (accessed 24 March 2010).

131 See for instance, *The Geneva Convention for the Amelioration of the Condition of the Wounded and Sick in Armed Forces in the Field*, opened for signature 12 August 1949, 75 UNTS 31, Article 2 (entered into force 21 October 1950). The four Geneva Conventions, and their two Additional Protocols of 1977 contain similar provisions.

132 The ICRC, for instance, has stated whether a situation amounts to an armed conflict should be determined on a case-by-case basis. See *International Humanitarian Law and the Challenges of Contemporary Armed Conflict* (2007) International Committee of the Red Cross, (Document prepared for the 30th International Conference of the Red Cross and Red Crescent, Geneva Switzerland, 26-30 November 2007) <http://www.icrc.org/Web/eng/siteeng0.nsf/htmlall/ihl-30-international-conference-101207/$File/IHL-challenges-30th-International-Conference-ENG.pdf> (accessed 24 March 2010).

133 Indeed, the ICRC argues that 'it is both dangerous and unnecessary, in practical terms, to apply IHL to situations that do not amount to war.' See International Committee of the Red Cross, 'International

other bodies of law that apply in the absence of an armed conflict, such as international human rights law, provide stricter rules on *inter alia* what constitutes the lawful taking of life.[134]

Combatants?

Another core concept of IHL is the notion of 'combatant'. The term 'combatant' in IHL defines who is entitled to participate in hostilities, and the consequences that flow from this right. For instance, a combatant may not be prosecuted for lawful acts committed during an armed conflict, but they may be targeted during the course of an armed conflict. However, the war on terror and the increasing use of UV technology is challenging traditional conceptions of who may be considered a combatant.

In respect of the countries operating UV technology, this change is twofold. The first, most obvious, difference is the replacement of human soldiers with robots in a variety of dull, dirty and dangerous roles.[135] The second difference is the product of the semi-autonomous state of current UV technology — the necessity of the 'human in the loop'.[136] Human UV operators exercise a great deal of influence over the conflict zone, although they are rarely physically located within it. In fact, they are more likely to participate in combat from a comfortable, office-type environment, with regular working hours.[137] Countries operating drones have thus experienced a significant shift in their fighting portfolios, with humans moving out of the conflict zone, and matching very different profiles to conventional soldiers.

Given the increasing reliance on UVs in armed conflict, it is unsurprising that the needs of military recruiters in drone-operating

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Humanitarian Law and the Challenges of Contemporary Armed Conflict', ibid.

134 Ibid.

135 Whilst the possibility of completely removing humans from the warzone is probably a long way off, UVs are now unquestionably embedded within the armed forces of many countries, undertaking the dull, dirty and dangerous roles that were once carried out by humans. So important are these 'drone warriors' to their human counterparts, that some members of the armed forces have given them honorary status as soldiers in their own right. Brown writes about an explosive ordinance team who were 'giving [a packbot UGV] a full military honors funeral … They said it took six wounds … That robot had saved their lives. It had crawled up next to bombs how many times and they had actually developed a fondness that oftentimes you develop for your shipmates when you're in tough times.' See Brown, above n 53.

136 Robert Sparrow, 'Predators or Plowshares? Arms control of robotic weapons' (2009) 28(1) *IEEE Technology and Society Magazine* 25, 26.

137 Stulberg, above n 9.

countries have changed. Rather than physical prowess, militaries seeking to recruit UV operators are now more interested in an individual's technical speed, ability to digest large amounts of information, long attention span and prowess at operating a computer console.[138] As a result, some militaries have begun to refocus their recruiting strategies; indeed going so far as to open recruiting centres resembling an arcade parlour in a suburban shopping mall[139] or redesigning UV controls to emulate those found on popular video game consoles so as to appeal to potential recruits 'trained' on years of video games.[140] This has worried some critics, who are concerned about a new breed drone operators possessing the 'Playstation mentality'. As Alston and Shamsi argue:

> Young military personnel raised on a diet of video games now kill real people remotely using joysticks. Far removed from the human consequences of their actions, how will this generation of fighters value the right to life? How will commanders and policymakers keep themselves immune from the deceptively antiseptic nature of drone killings? Will killing be a more attractive option than capture?[141]

Similarly, much has also been said about the physical (and perhaps also psychological) removal of the operators from the combat zone, and the effect this may have on decisions to use lethal force.[142] Critics often raise the example of a civilian operating a drone out of Nevada as part of a nine-to-five job, before returning home for dinner.[143]

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138 Brown, above n 53, 28.

139 The US Air Force, for instance, now operates a recruiting centre filled with video games emulating aerial combat from a suburban shopping mall in Philadelphia. See Jon Hurdle, 'U.S. Army Using Video Games to Recruit at Shopping Malls' *Reuters* (online) 9 January 2009, <http://www.reuters.com/article/idUSTRE50819H20090110> (accessed 12 March 2010).

140 Israeli defence companies, for instance, model their UAV controllers on Playstation consoles and controllers on the premise that they can be piloted by 'an average 18 year-old recruit with just a few months training.' See Levinson, above n 31. The Crusher UGV can reportedly be controlled from an Xbox or even iPod console by troops on the ground. See Mark Scott, 'Raytheon Taps Video Games to Pilot Drones' *Bloomburg BusinessWeek* (online) 16 July 2008, <http://www.businessweek.com/globalbiz/content/jul2008/gb20080716_470794.htm> (accessed 1 February 2010).

141 Philip Alston and Hina Shamsi, 'A Killer above the law? Britain's use of drones in the war in Afghanistan must be in accordance with international law' *Guardian.co.uk* (online) 8 February 2010, <http://www.guardian.co.uk/commentisfree/2010/feb/08/afghanistan-drones-defence-killing> (accessed 15 March 2010).

142 O'Connell, above n 116, 9.

143 Ibid.

Such operators, located far away from conflict, face no danger while at work. They never see the victims with their own eyes, and are unaware of the effect a hovering drone on the population below. Critics suggest that this will further dissociate these operators from the human cost of the killing they are involved in.[144] O'Connell, for example, argues that this removal from the battlefield is a 'structural feature of drone operations that affects the ability to use them consistently with the law of armed conflict.'[145] However, as Sparrow has pointed out,

> the force of this objection to the development of robotic weapons is greatly mitigated when we consider the nature of what the use of such weapons might replace. Shelling from a battleship miles offshore or conducting area bombing from a B-52 hardly involves much contact with, or respect for, the individuals one is killing.[146]

Somewhat ironically, there is also concern that the increasing use of UV technology may lead to a greater likelihood of IHL violations by a belligerent party, as they attempt to overcome the superior military strength and technological capabilities of their opponent. In other words, it is possible that 'military imbalances carry incentives for the weaker party to level out its inferiority by disregarding existing rules on the conduct of hostilities.'[147] So-called 'asymmetric' warfare is said to lead technologically disadvantaged groups to exploit the protected status of certain people or objects in order to conceal themselves[148] or to strike 'soft targets', namely civilians, either to inflict the greatest damage, or because they are unable to attack military personnel or objects.[149] While asymmetric warfare is, again, not a new phenomenon, UV technology has served to further increase the disparity between military and technological strength of belligerent parties in some conflicts. In particular, the ability of UAVs to engage in persistent surveillance of previously inaccessible areas and to strike identified targets, has led insurgents to move to more remote areas or to cross borders. Conversely it may also lead insurgents into populated urban areas to avoid detection.[150] In the former scenario, the result is an increasing need for militaries to target individuals in remote areas, or in countries in which they have

144 Ibid, 10.

145 Ibid.

146 Sparrow, above n 136, 26.

147 See International Committee of the Red Cross, above n 132.

148 Under IHL 'protected' status is conferred upon *inter alia* civilians, civilian objects, medical objects, cultural and religious sites.

149 See International Committee of the Red Cross, above n 132.

150 See Cordesman, above n 24, 21.

no ground presence. This, in turn, leads to an increasing reliance on UAV technology.

Civilian killers:

As may be inferred from the discussion above, there are in fact two US drone offensives currently being operated: one conducted by the armed forces, the other by the CIA.[151] Although there is some suggestion that the two programs overlap and are undertaken with a significant amount of cooperation,[152] it is generally considered that the drone program run by the armed forces is publicly acknowledged, and 'operates in the recognised war zones of Afghanistan and Iraq... as such, it is an extension of conventional warfare.'[153] In contrast, the CIA drone program operates in almost complete secrecy, rendering accurate assessments on the number of drone strikes and their victims, next to impossible.

The CIA drone program has given rise to some IHL-related criticisms, assuming of course that IHL applies to some, or all, of the strikes carried out by the CIA (see above). The main criticism is the alleged lack of accountability of CIA employees for breaches of IHL. Statistics and media reports on drone killings conducted by the CIA give some cause for concern.[154] For instance, Pakistani officials alleged that drone strikes in Pakistan in 2009, killed 700 civilians and only 14 militants,[155] while an independent study suggested that

151 Gary Solis, 'CIA drone attacks produce America's own unlawful combatants'' *The Washington Post* (online) Friday 12 March 2010, <http://www.washingtonpost.com/wp-dyn/content/article/2010/03/11/AR2010031103653.html> (accessed 12 April 2010).

152 O'Connell, above n 116, 7.

153 Ibid, 6.

154 See Peter Bergen and Katherine Tiedemann, *The Year of the Drone: An Analysis of U.S. Drone Strikes in Pakistan, 2004-2010* (February 24 2010) Counterterrorism Strategy Initiative Policy Paper, New America Foundation <http://counterterrorism.newamerica.net/sites/newamerica.net/files/policydocs/bergentiedemann2.pdf> (accessed 12 April 2010) on the difficulty of compiling reliable statistics on casualties in remote areas of Pakistan. One problem they note is the difficulty in distinguishing between militants and civilians, as militants often live amongst the population and do not wear a uniform.

155 David E Anderson, *Drones and the Ethics of War* (14 May 2010) Religion and Ethics Newsweekly, Public Broadcasting Service (PBS) http://www.pbs.org/wnet/religionandethics/episodes/by-topic/middle-east/drones-and-the-ethics-of-war/6290/. At the other end of the spectrum, US officials have alleged that 'just over 20' civilians and 'more than 400 fighters' had been killed in less than two years. See Bergen and Tiedemann, above n 154.

about two-thirds of the total individuals killed by drones in Pakistan were civilians.[156]

As Mayer argues, the CIA does not provide any 'information to the public about where it operates, how it selects targets, who is in charge, or how many people have been killed.'[157] Thus whether or not all or some operations are joint operations between the US armed forces and the CIA, or whether the CIA conducts its own operations, serious questions are raised in relation to accountability.[158] Indeed, the Geneva Conventions contain reasonably detailed provisions aimed at ensuring the compliance of armed forces with IHL.[159] Given the significant number of drone strikes being carried out in the CIA program, this lack of accountability raises the serious possibility that IHL, where it is applicable, may not be being followed or enforced, and thus ultimately undermined. Of course, the oft-cited maxim that justice must not merely be done, but must also be seen to be done, is also applicable here.[160]

7.1.2 Do Paradigm Shifts Require Legal Shifts?

It is debateable whether UVs create any new legal issues. Targeted killings, asymmetric warfare and civilian participation in hostilities all existed before the recent UV revolution. Nevertheless, it is undeniable that the use of such technology has greatly increased the frequency of these forms of combat and thus exacerbated the

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[156] See Bergen and Tiedemann, above n 154.

[157] Jane Mayer, 'The Predator War: What are the risks of the C.I.A.'s covert drone program?' *The New Yorker* (online) 26 October 2009, <http://www.newyorker.com/reporting/2009/10/26/091026fa_fact_mayer> (accessed March 13 2010).

[158] Hauri has argued that 'the secrecy surrounding the CIA drone strikes program obscures the possible consequences if something goes wrong, as no visible structures of accountability are in place.' Similarly, Alston has described the CIA program as operating in an 'accountability void'. Walzer has argued that 'there should be a limited, finite group of people who are targets, and that list should be publicly defensible and available.' See Andrin Hauri, *Obama's drone handicap* (17 May 2010) International Relations and Security Network, Security Watch, <http://www.isn.ethz.ch/isn/Current-Affairs/Security-Watch/Detail/?ots591=4888caa0-b3db-1461-98b9-e20e7b9c13d4&lng=en&id=116243> (accessed 15 March 2010); Michael Walzer, quoted in Mayer, ibid; Mayer, ibid.

[159] See *Protocol Additional to the Geneva Convention of 12 August 1949, and Relating to the Protection of Victims of International Armed Conflict*, opened for signature 8 June 1977, 1125 UNTS 3 ('Additional Protocol I'), Part V, Section II (entered into force 7 December 1978). These include obligations on commanders to prevent and suppress breaches, including the duty to initiate disciplinary or penal action against violators.

[160] *Rex v Sussex Justices, Ex parte McCarthy* [1924] K.B. 256, 259.

associated legal uncertainties. As stated above, UVs are changing the very nature of warfare into a more global concept, unconstrained by conventional notions of war. The pertinent question is thus whether the current laws remain relevant in light of the more recent patterns of conflict that have developed with the advent of UV technology.

Beyond circumventing or stretching conventional notions of warfare and the laws of war, concern has been raised that UVs have the potential to change the perceptions of war amongst participants and publics. As participants move away from the conventionally defined battlefield they may indeed become more desensitised to the death and destruction they are responsible for.[161] In addition, UVs might also lower socio-political barriers to war, insofar as the reduction in civilian casualties makes the public more willing to enter into, and sustain overseas engagement. Finally, it may be that states become more willing to use force outside of the traditional confines of a declared armed conflict, because UVs allow those states to extend their reach into previously inaccessible countries with no military presence.

In the past, mechanisms of engagement, such as targeted killing in foreign countries, were limited by practical and political constraints. Many of these normative control structures have now been removed through the use of UVs, and it is worth considering whether a restructuring, refocussing or strengthening of the relevant laws might be necessary.

8. *Beyond the Military – The Transition to Civilian Use*

In this section we consider the civilian uses of UVs, both now and into the future. Whilst a significant amount of dialogue has begun to be generated about the social, ethical and legal implications of UVs in warfare, there has only been limited discussion of such issues in relation to the use of UVs for civilian purposes. Whilst that is no doubt because the technology has not saturated that sector as much as it has the military one, we consider it to be important that social, ethical and legal implications of UVs are discussed in advance of the technology really taking hold, because it is likely to have a major influence on the way a wide range of public and private sector organisations operate with relation to the public.

We noted above that UVs have not been used as extensively for civilian purposes as they have military ones. We also highlighted two exceptions to this general rule, the first being limited agricultural use and the second, undersea operations. Whilst the former represented only a very small component of global industrial

161 We accept that this is arguable, As per Sparrow's arguments above. See Sparrow, above n 136, 26.

usage, UVs played a dominant role in the latter. Indeed, it is said that the 'golden age' of UUV technology occurred more than a decade before the UAV revolution, when the public were provided footage of undersea wrecks like the Titanic through the tethered cameras of robotic submersibles.[162] As groundbreaking and popular as such operations were, they were actually made possible because of a knowledge and resource pool created by virtue of commercial and industrial uses of the technology; for instance, as petrochemical and mineral extraction, or subsea pipeline and cable laying and maintenance.[163] Those industries have a particular interest in developing robotic technologies that could supplant humans in the undertaking of 'dirty, dangerous or dull' jobs in alien, high risk, environments. Above the water however, there was much less of an impetus to the development of expensive alternatives to human operated vehicles and UV development has therefore historically been driven the military sectors of wealthier nations seeking to transfer the risk from human combatants to machine ones.

Recently there has been marked transition from military to civilian uses for drone technologies. This has been driven by a number of factors:

- Inter-agency transfer: As drones have moved beyond being highly expensive prototype hardware to more mainstream military and research vehicles there has been an increasing willingness for inter-agency transfer of drones for civilian use or trails.[164]

- Increasing international demand: As a result the of the increasing market competition for ever an ever wider range of countries unmanning their military sectors, the price of drones has decreased significantly bringing them within reach of non-military bodies, whom manufactures view as an important new market.[165]

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162 In fact, the first 'golden age' in UV technology occurred under the oceans more than a decade before it did in the air. See Henderson, above n 17, 57.

163 Stephanie Showalter, 'The Legal Status of Autonomous Underwater Vehicles' (2004) 38(1) *Marine Technology & Society Journal* 80.

164 For instance, armies have provided drones to police forces for trials, air forces have similarly provided UVs to search and rescue teams to deal with large-scale emergencies. See R Johnson, *NASA drones aid firefighters* (2008) *Electronic Engineering Times* 1535, 9-10; Randal C Archibold, 'U.S. Adds Drones to Fight Smuggling' *New York Times* (New York, New York) 8 December 2009, A.25; and Graham Warwick, 'Drug Drones' (2009) 170 *Aviation Week & Space Technology* 22.

165 Stafford writes that when 'commercial drones do take off, four groups of businesses would be looking to cash in. Academic researchers … [with] associations with small, specialist companies that build UAVs.

- Public R&D Support: The massive R&D push into drone technology and computing generally has brought both know-how and inexpensive technology into the wider public arena.

- Increased access to powerful hardware platforms: Over the past two decades computing power and hardware systems have become incredibly powerful, inexpensive and, more importantly, widely available to commercial markets.[166] Consumers can now purchase 'off the shelf' systems that are almost, if not as, complex and powerful as those available to the military.[167] Conversely, the military has become increasingly reliant on commercial hardware, consequently much of the technology used in the construction of UVs are available on the open market.[168]

Drone technology is increasingly within the reach public bodies, private companies and even individuals. This trend will most likely continue. We have already set out some of the roles that UVs are being used for by such bodies, recognising that as the technology becomes more accessible a range of other applications will no doubt come online.

Border security and customs roles are particularly well suited to UAVs,[169] which are now used to detect illegal transborder activities,

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Older commercial companies … have long sold drones as toys. A handful of major corporations already have a toe-hold in the market. And military contractors have perfected the secret designs of the world's best-performing drones — those already used by air forces and spy agencies.' See Ned Stafford, 'Spy in the sky' (2007) 7130(445) *Nature* 808.

166 David S Alberts, The Unintended Consequences of Information Age Technologies: Avoiding the Pitfalls, Seizing the Initiative, (2004) 26–28.

167 Indeed, modern military vehicles and platforms often rely on a mix of military grade and commercially available technology. Jay Stowsky, 'Secrets to shield or share? new dilemmas for military R&D policy in the digital age' (2004) 2(3) *Research Policy* 257. As Gormley notes, 'Military breakthroughs are increasingly resulting from commercial, rather than secret military, research...' Dennis M Gormley, 'Hedging Against the Cruise-Missile Threat' (1998) 40(1) *Survival* 92.

168 As the US Administration admits, 'Technological advances in propulsion that were previously driven by military-sponsored research are now largely driven by commercial interests—fuel cells by the automotive industry, batteries by the computer and cellular industries, and solar cells by the commercial satellite industry. [UVs] are therefore more likely to rely on COTS [Commercial off the shelf] or COTS-derivative" systems.' US OSD Roadmap note 8, 52.

169 For instance, Reaper drones are now deployed by the international anti-piracy task force to scout for Somali pirates in the Indian Ocean. The drones are operated from a base in Germany to follow and record movements of suspect pirate vessels. Although many boats have been

border infringements,[170] drug[171] and people smuggling.[172] More often than not, these agencies utilise craft, such as the Predator drone, which are directly seconded from the military and, as of yet, it is rare to find UVs specifically designed for non-military surveillance.

Policing is another sector in which UVs are beginning to appear. The British police have been particularly enthusiastic about UVs and, under the rubric of the UK Government Home Office, have been developing a nationwide drone program since at least 2007.[173] The program reportedly includes trialling medium and low altitude UAVs, with an arrest being assisted by the use of a small UAV for the first time in 2010.[174] The UK UAV program is expected to deploy test drones by the end of 2010, and be fully operational by 2012, in time for the Olympics which are being hosted in London.[175] The UK

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captured it has been extremely hard to prove that they were involved in piracy. The ability of the drones to capture video of suspect movements, over long periods of time (up to 18 hours) without detection makes them perfect for the detection and evidence-gathering role.
See Will Ross, 'Drones Scour the Sea for Pirates' *BBC News* (online) 10 November 2009 <http://news.bbc.co.uk/2/hi/africa/8352631.stm> (accessed 15 March 2010).

170 Countries like Australia, who have larger border areas are reportedly trialling semi-autonomous patrols of large areas of its northern approaches. See Ari Sharp 'Unmanned aircraft could soon patrol borders' *The Age Newspaper* (online), April 6, 2010 <http://www.theage.com.au/national/unmanned-aircraft-could-soon-patrol-borders-20100405-rn4l.html> (accessed 1 May 2010).

171 In late 2009, the US Department of Homeland Security expanded its use of drones into external jurisdictions, including the Caribbean and South America to spot and track drug smugglers. See Archibold, above n 164. The US Navy is also trialling drones over unspecified countries, seeking to use them to detect submersible vehicles which have been used to smuggle drugs into the US. See Warwick, above n 164.

172 US Predator drones for instance have been used to patrol the Canadian and Mexican borders. See Warwick, above n 164.

173 Paul Lewis, 'CCTV in the sky: police plan to use military-style spy drones', *The Guardian* (online) 23 January 2010, <http://www.guardian.co.uk/uk/2010/jan/23/cctv-sky-police-plan-drones>. However, note an earlier talk by the Home Office which was reported by La Franchi. See Peter La Franchi, 'UK Home Office plans national police UAV fleet', *Flight International* (online) 17 July 2007, <http://www.flightglobal.com/articles/2007/07/17/215507/uk-home-office-plans-national-police-uav-fleet.html>.

174 'Unlicensed police drone grounded', *BBC News* (online) Tuesday, 16 February 2010, although no conviction was recorded. <http://www.clickliverpool.com/news/national-news/128901-merseyside-police-drone-fails-to-convict-car-thief.html>.

175 See Lewis, above n 173.

program envisions military UAVs being modified for a wide range of civilian law enforcement activities, including 'routine monitoring of antisocial motorists, protesters, agricultural thieves and fly-tippers'[176] as well gathering evidence of 'vandalism, graffiti or littering.'[177]

According to reports, other police forces have also sought to arm ground and aerial drones with tasers for non-lethal engagement of suspects.[178] Although this could not be verified by the authors, two French companies market small and micro UAVs which can variously be armed with a 44mm flash-ball-gun,[179] tear-gas canisters,[180] or tasers.[181]

Patrolling & Inspection. The need to patrol large restricted areas is not limited to the military. Various industries require ground and air surveillance. For instance, semi-autonomous UGVs have been suggested for a range of industries including: nuclear and electric power plants; railway lines and tracks; sensitive industrial and research areas; oil and gas pipelines, refineries and storage areas; zoos, wildlife reserves and safaris and even private farms and ranches.[182] Semi-autonomous patrol vehicles are obviously well suited to monitoring gaols and detention centres, many of which are now privately operated.[183] Dull and routine operations, such as car parking inspection, have also been highlighted as a possible role for semi-autonomous UGVs.[184] Similarly, the need to inspect cars and

176 Ibid.

177 David Hambling, 'Future Police: Meet the UK's Armed Robot Drones' *Wired News* (online) 10 February 2010, http://www.wired.co.uk/news/archive/2010-02/10/future-police-meet-the-uk%27s-armed-robot-drones (accessed 25/5/2010).

178 Ibid. However, the author's could find no official verification of this.

179 'Tecknisolar Seni designs armed mini-UAV for anti-terror operations' *Flight International*, (online) 22 June 2004, <http://www.flightglobal.com/articles/2004/06/22/183201/eurosatory-2004-tecknisolar-seni-designs-armed-mini-uav-for-anti-terror-operations.html> (accessed 25/5/2010).

180 Ibid.

181 See iDrone Website, <http://www.idrone.fr/index.php?option=com_content&view=category&layout=blog&id=39&Itemid=59> (accessed 20 March 2010).

182 See Israel Aerospace Industries Ltd promotional website: <http://www.iai.co.il/34056-31663-en/Groups_Military_Aircraft_Lahav_Products_UGV.aspx> (18 April 2010).

183 Douglas McDonald, 'Public Imprisonment by Private Means - The Re-Emergence of Private Prisons and Jails in the United States, the United Kingdom, and Australia' (1994) 34 *British Journal of Criminology* 29, 29.

184 Richard Bloss, 'By air, land and sea, the unmanned vehicles are coming' (2007) 34(1) *The Industrial Robot* 12, 14.

vehicles for bombs or other hazards is not limited to the military; security firms protecting hotels, conference centres and other organisations at risk of terrorist activities are very interested in robots that can undertake these dangerous tasks.[185]

Emergency and hazard management. Adapted military drones have also proven successful in emergency management fire fighting, where they can be used for monitoring operations in dangerous environments.[186] For instance, predator drones with specially designed heat sensors were provided to Californian authorities to help them battle against the massive wildfires that ravaged that state in 2008.[187] In that case only fire surveillance was provided, but in the future, custom-built fire fighting and water bombing UAVs may be used to combat fires, removing human pilots from the high-risk environment of wildfires.

UVs also promise to provide ground support in areas inaccessible to rescue crews. Small teleoperated and semi-autonomous UGVs designed for reconnaissance in houses and caves are well adapted to exploring earthquake, disaster zones and other hazardous terrain for survivors.[188] Both the Japanese fire service[189] and the Israeli military[190] have been have been trialling rescue UVs that can rescue injured persons in high-risk areas. Not only would these be important in troop rescue, but they also could be used to extract civilians from remote regions, disaster zones, fires or even riots.

Remote exploration works and repair. In the undersea environment, UUVs have been used for decades to undertake repairs to hulls,

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185 Ibid.

186 Fire fighters can be blinded by smoke and debris during firefighting operations and wander into areas that are dangerous. For instance, certain regions of the fire may be too hot for humans, or areas of the ground may be covered in ash that would cause the firefighters' boots to melt.

187 Heat detecting and radar equipment were retrofitted to the drones so that they could 'see through' the smoke layer to provide fire fighters with up-to-the-minute intelligence on the fire as well as any obstructions, hazards or impediments not visible to human eyes on the ground. Johnson, above n 164, 9-10.

188 Brian Yamauchi and Pavlo Rudakevych, 'Griffon: A Man-Portable Hybrid UGV/UAV' (2004) 5(31) *Industrial Robot* 443, 443.

189 Brian Ashcraft, 'Just Press "Save": Disaster search-and-rescue in robot-crazy Japan' (2009) *Popular Science* (online) 14 May 2009, <http://www.popsci.com/scitech/article/2007-07/autonomous-flying-ambulances-could-save-troops#> (accessed 2 February 2010).

190 David Axe, 'Autonomous Flying Ambulances Could Save Troops' (2007) *Popular Science* (online) 7 November 2007, <http://www.popsci.com/scitech/article/2007-07/autonomous-flying-ambulances-could-save-troops#> (accessed 2 February 2010).

pipelines, or oil rigs.[191] More autonomous UUVs are being developed which will undertake this work automatically.[192] Similar systems are in development on land, including maintenance of remote drilling stations as well plumbing and maintenance robots that travel subterranean sewer pipes monitoring for weakness or structural breaches, automatically repairing the damage, or, where that is not possible, recording and alerting controllers to it.[193]

Israeli companies have produced a range of heavy UGVs for bulldozing and earthmoving, which are in active use to undertake structural works under fire. Whilst teleoperated, future earthmoving UGVs are likely to be automated to undertake routine maintenance of runways, fire-trails, civil engineering, resource transport, or clearing forest and farmland.[194]

Urban Transport. Whilst UGVs are able to operate off-road and in for limited on-road military uses, it is relatively well accepted that they are not yet ready for the nontrivial navigation required to operate on public highways and roads.[195] Despite this, there have been concerted efforts to advance the technology to a level where it can safely operate in civilian traffic zones. Proponents hope that one day automated vehicles will act as taxis, reduce traffic congestion, combat global warming emissions, and reduce road fatalities.[196] Both the US and the European Union have been funding autonomous UGV research and development since the 1980s. The US *Defense*

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191 Carl E Nehme, *Modeling Human Supervisory Control in Heterogeneous Unmanned Vehicle Systems* (PhD thesis, Department of Aeronautics and Astronautics, Massachusetts Institute of Technology, 2009) 28.

192 Ibid.

193 Researchers at the University of California, Irvine are developing drone technology which would repair aging subterranean pipes from the inside using carbon fibre. See Tom Vasich, *No Mere Pipe Dream* <http://www.uci.edu/features/2010/02/feature_piperobot_100208.php> (accessed 12 January 2010).

194 Howard Cannon, *Extended Earthmoving with an Autonomous Excavator*, (Master's thesis, Technical Report CMU-RI-TR-99-10, Robotics Institute, Carnegie Mellon University, 1999).

195 The nontrivial navigational requirements for civilian motor traffic are simply beyond most of today's artificial intelligence systems. Semi-autonomous UVs must deal with complex road rules, highly congested traffic, varying road and weather conditions and non-automotive traffic such as cyclists and pedestrians. More to the point, they must deal with other vehicles that may not be strictly adhering to the same road rules they will be programmed with along with unexpected events, emergencies or impediments (such as a child or animal straying onto the road).

196 See, for instance, see futurist and urban designer Michael Arth's, forthcoming book, 'The Labors of Hercules: Modern Solutions to 12 Herculean Problems' (online) 2009 <http://michaelearth.com/herc_V_eco.html> (accessed 26 May 2010).

Advanced Research Projects Agency (DARPA) has attempted to encourage public sector involvement in UGV autonomy through the DAPRA Grand Challenges, a series of task-based competitions pitting different UGVs against each other, most recently in the urban environment for a total prize pool of US$3.5.[197] Some even hope to have such cars on the road by 2015.[198]

Other areas. The civil use of UAVs could be significant and extensive: private and insurance investigation; event coverage; traffic management and monitoring; fisheries protection; real-time disaster reconnaissance and management; coverage of large public events; mechanized agriculture; power line surveying; aerial photography; environmental monitoring and so on.

8.1 Regulatory Constraints

The relative cost savings promised by UVs, especially UAVs have excited many commercial operators. However, regulators have been reluctant to allow unmanned vehicles into domestic traffic routes. Operating a UV in a war zone, particularly where one side has dominance and (ostensible) control over the airspace, waterways or roads is very different to dealing with the crowded civilian equivalent. This is particularly true of the highly controlled medium altitude airspace, which is heavily trafficked and requires a great deal of expertise to operate from within and manage from outside.

8.1.1 International Civil Aviation Law

Medium altitude UAVs operating in conflict zones have had a particularly high accident rate, with a recent report indicating that of 135 Predator planes delivered and used in military operations, 50 have been lost and 34 have had serious accidents. This is an accident rate 100 times higher than manned aircraft.[199] It is relatively well accepted that the reasons for such disparities are broader than the mere fact that, by their very nature, UAVs are placed in high-risk

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197 The Challenge aims to develop 'technology that will keep warfighters off the battlefield and out of harm's way. The Urban Challenge features autonomous ground vehicles maneuvering in a mock city environment, executing simulated military supply missions while merging into moving traffic, navigating traffic circles, negotiating busy intersections, and avoiding obstacles.' See DARPA, Urban Challenge Overview, http://www.darpa.mil/grandchallenge/overview.asp (accessed 2 April 2010). However, a civilian car maker has been eying the technology, see Jon Stewart, 'Robot cars race around California' *BBC News* (online) 5 November 2007 <http://news.bbc.co.uk/go/pr/fr/-/2/hi/technology/7078245.stm> (accessed, 25 May 2010).

198 Ibid.

199 Stafford, above n 165, 808.

combat environments.[200] A number of reasons have been highlighted as the cause of this, not least because UAVs are designed around efficiency and weight loss arising out of removing many of the safety features designed to protect a human pilot leaving them with many single points of failure.[201] Similarly, some failures have been attributed to ground staff not putting enough care and attention into the maintenance of UAVs as a pilots life is not on the line; an attitude that may arguably change should UAVs begin operating in civilian airspace.[202] Moreover, UAV safety personnel need to consider a range of hardware, beyond the aerial vehicle itself, which includes the various componentry that makes up the unmanned system 'suite'.[203] Not only does this require a wider spectrum of maintenance inspections, but it will also require ground-staff to have a broader skill-set than has been required for conventional aircraft.[204]

Not having a pilot onboard to report back to that ground crew about problems experienced in flight is also cited as a potential issue.[205] This is true of all forms of semi-autonomous UVs; the very point of controlled autonomy is that the craft takes care of itself until a human operator is needed to make critical decisions. 'Automation-induced complacency'[206] is a recognised problem with single craft; as USVs become part of larger and larger 'swarms' overseen by single controllers the potential for single craft complacency may grow.[207] In

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200 Alan Hobbs, 'Human factors, the last frontier of aviation safety?' (2004) 14(4) *International Journal of Aviation Psychology* 331, 335-341.

201 Hence, UAVs will often have a single point of failure for many flight, electrical and communications systems, something unacceptable in civil aviation. 'FAA: Drones Not Ready for Prime Time' (2009) 44(23) *Air Safety Week*.

202 Alan Hobbs and Stanley R Herwitz, 'Human Challenges in the Maintenance of Unmanned Aircraft Systems' (San Jose State University Foundation, NASA Ames Research Center Publication, 2006) 17.

203 Adams writes: 'UAS maintainers need to know a lot. You've got to know your bits and bytes …but at the same time, you've got to be able to adjust the carburetor.' Charlotte Adams, 'Technology Focus: Unmanned Vehicle Maintenance' *Aviation Maintenance Magazine* (online) Thursday, 1 November 2007, <http://www.aviationtoday.com/am/categories/commercial/Technology-Focus-Unmanned-Vehicle-Maintenance_16794.html> (accessed 21 May 2010).

204 Ibid.

205 Ibid.

206 R Parasuraman, R Molloy and I L Singh, 'Performance consequences of automation induced complacency.' (1993) 3(1) *International Journal of Aviation Psychology* 1.

207 J J Spravka, D A Moisio and M G Payton, *Unmanned Air Vehicles: A New Age in Human Factors Evaluations. In Flight Test – Sharing Knowledge and Experience* (2005) Meeting Proceedings RTO-MP-SCI-162, Paper 5A,

the case of USVs, a human controller may be operating up to fifteen craft simultaneously.[208] Indeed, the dissociation of not actually being in the cockpit is one factor attributed to the high rate of drone accidents.[209]

As a result of the ongoing problems with UAVs, civil aviation authorities around the world have, thus far, been reluctant to permit drones to share the same airspace as commercial traffic.[210] This discrimination between manned and unmanned aircraft is permitted under the 1948 *Chicago Convention on International Civil Aviation ('Chicago Convention')*, which provides for international regulation of civilian air traffic. Article 8 of that Convention states:

> No aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a Contracting State without special authorisation by that State and in accordance with the terms of such authorisation. Each Contracting State undertakes to insure that the flight of such aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft.[211]

No contracting state has yet set out rules or terms of authorisation for UAVs and their use is therefore currently restricted to individual licenses granted to specific operators within individual countries.[212]

Neuilly-sur-Seine, France, <http://www.rto.nato.int/abstracts.asp.> (accessed 25 May 2010).

208 See Civil Aviation Authority of New Zealand, *Unmanned Aerial Vehicles Issues Paper,* 22 January 2007, 10 ('NZ CAA').

209 Karp and Pasztor write, 'Air Force officials say that all of the crashes so far were the result of malfunctions or errors by pilots who are often as far away as Nevada and lack the sensation of being in the cockpit.' Jonathan Karp and Andy Pasztor, 'Drones in Domestic Skies?' *Wall Street Journal* (New York, New York), 7 August 2006, B1.

210 Ibid. See also NZ CAA, above n 208. For Europe see, David Hughes, 'UAV Road Map for Europe' 168(15) *Aviation Week & Space Technology* 78. For Australia see, Civil Aviation Safety Authority Australia, *Unmanned Aircraft and Rockets: Unmanned Aerial Vehicle Operations, Design Specification, Maintenance, and Training of Human Resources*, (Advisory Circular 101-1(0) Canberra, Australian Capital Territory, 2002).

211 *Convention on International Civil Aviation*, opened for signature 7 December 1944, 15 UNTS 295 (entered into force 4 April 1947).

212 Kaiser, above n 58, at 348 argues that Article 8 is broad enough to cover any form of UAV that could be deployed to another convention party's airspace. Within that context, UAVs must be operated in such a way that does not endanger civilian aircraft. However, as he points out, the *lex specialis* nature of the Convention means that it only applies to civilian UAVs. Indeed art 3(a) of the Convention explicitly excludes 'state aircraft' which include military, customs and policing aircraft. However, the Convention does require that a contracting party obtain

Although the civil aviation authorities in many contracting states have formed working groups aimed at creating specific regulatory frameworks for UAVs in civilian airspace,[213] there is a general recognition that regulatory approval may be some years away. This is due in part to the terrible safety record of current UAVs, but also because proponents have yet to prove to commercial regulators that other core requirements of the *Chicago Convention* are satisfied. That includes proving the craft has the ability to see and avoid nearby aircraft, has open communication and control systems for emergencies, and has sound collision avoidance principles.[214]

Despite envisioning UAVs in Article 8, much of the *Chicago Convention* and its annexes were designed to deal with conventional aircraft, and are thus based on the assumption that the 'pilot' is a human. As such, many of the regulations about visual flight rules and communication can be moulded to fit UAVs where there is controlled autonomy, but not full autonomy. This could be overcome by ensuring humans operate the aircraft directly at critical times, however, the problem of situations of broken communication remains.[215] Although auto-pilots and artificial intelligence systems could take over at these points, it would appear the aircraft would

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the authorisation of another contracting party before flying state aircraft over their airspace (art 3(c). Kaiser argues (at 349) that the wording of arts 3(c) and 8 (specifically the second sentence) may be interpreted to require state aircraft to also comply with civilian aviation rules designed specifically for unmanned aircraft. That interpretation is by no means certain and is more likely to rely on the goodwill and understanding of the parties.

213 See for instance, Transport Canada UAV Working Group Website <http://www.tc.gc.ca/eng/civilaviation/standards/general-recavi-uavworkinggroup-2266.htm> (accessed 25/5/2010); Eurocae Working Group 73 Website <http://www.eurocae.net/workinggroups.html> (accessed 25 May 2010).

214 The Convention requires that Visual Flight Rules (Annex 2 Chapter 4 of the Convention) are complied with. However, these are drafted in terms of contemporary manned aircraft. Specifically, there must be visible control by the pilot operating the flight, altitude control, navigation and avoidance of other traffic; that UAVs flying in controlled airspace maintain contact channels with air traffic control, which would oblige a voice data link back to a human controller should air traffic control seek to direct the UAV (see Kaiser, above n 58, 353); and adhere to collision avoidance principles – 'vigilance for the purpose of detecting potential collisions be not relaxed on board aircraft in flight and when operating on the manoeuvring area of an aerodrome': *Convention on International Civil Aviation*, opened for signature 7 December 1944, 15 UNTS 295 (entered into force 4 April 1947) art 3.2.

215 As happened in a recent crash of a Predator Drone in the United States. See Chris Johnson and Christine Shea, 'The Hidden Human Factors in Unmanned Aerial Vehicles' *Proceedings of the 26th International Conference on Systems Safety*, Vancouver Canada, August 2008.

technically be flying blind in violation of the Convention. Resolving such issues will arguably require a mixture of technical improvements and regulatory review.

8.2 Maritime Law

Like the aerospace domain, passage across the oceans is covered by a wide range of domestic and international law. Much of that law is beyond the scope of this paper, but it is worth noting that UUVs and USVs operating in the ocean will be required to comply with a wide range of laws covering the maritime domain, including admiralty law, which also contains assumptions that seagoing vessels are human-operated. Outside of the body of private international admiralty law, there is a wide range of treaties enacted under the auspices of the International Maritime Organization (IMO). The most important of these is the 1972 IMO *Convention on the International Regulations for Preventing Collisions at Sea* (COLREGs), which set out the international 'road rules' for the passage of vessels.

COLREGs are intended to cover a wide range of sea-going craft. However, like other treaties and laws created before the proliferation of UV technology they tend to assume the existence of a human controller. Under COLREGs, 'vessel' is defined as including 'every description of watercraft … used or capable of being used as a means of transportation on water'. The obvious problem here is the use of the word 'transportation', which requires that vessels must transport *something* or *someone*.[216] Whilst many USVs and UUVs will in fact be used for transportation, others may be sealed units, such as exploratory, surveillance or mapping craft.[217]

Assuming all or some USVs and UUVs are covered by COLREGs, those vehicles will need to be designed to meet its requirements, in particular they must obey the 'rules of the road' on the oceans, operate in a safe manner and be visible to other craft.[218] USVs and surface UUVs operating autonomously or under the direction of a controller would need to be programmed to respect such laws when operating on international waters.[219] However, like aerospace law,

216 The Oxford English Dictionary defines 'transport' as 'To take or carry from one place to another by means of a vehicle, aircraft, or ship.'

217 Arguably these craft might fall under the ambit of the definition as they transport scientific and sensor equipment, although this seems to be taking a rather liberal approach to statutory interpretation.

218 These include rules to do with the lighting of the vessel; speed, steering and sailing rules and what sounds and signals are to be used in differing situations.

219 *Convention on the International Regulations for Preventing Collisions at Sea* opened for signature 20 October 1972, 1050 UNTS 16, (entered into force 15 July 1977) ('COLREGs'); and *International Regulations for*

such rules also betray an assumption of a human occupant by the drafters; for instance, requiring that a 'vessel shall at all times maintain a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision.'[220] Just how this provision would be interpreted in a controlled autonomy UV situation is unclear.[221]

COLREGs also centres upon the control status of a vessel, for instance setting up a hierarchy of categories, the most serious of which are 'vessel[s] not under command' or 'restricted in her ability to manoeuvre.' These categories oblige the vessel and other vessels navigating in its vicinity to respect certain rules, including that other vessels 'keep out of the way' of a vessel so categorised. A teleoperated vessel is clearly under command, but beyond this the issue is somewhat unclear. Given current commercial USVs can be operated in groups of up to fifteen vessels from one single control unit, there is cause to question whether each individual vessel is actually 'under the command' of the relevant single human operator. In the alternative, individual vessels within such a swarm might be defined as 'restricted in their ability to manoeuvre', but that would most likely depend on their level of autonomy, how routine the operations they were involved in are,[222] and their ability undertake non-trivial navigation in response to environmental stimuli.

In its current form the COLREGs regime seems to provide autonomous vehicles with a navigable right-of-way over any other vehicles directly under command. If that were the case, it would also

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Preventing Collisions at Sea, opened for signature 17 June 1960, 1967 ATS 7, (entered into force 1 September 1965) ('COLREGs 1960').

220 *Convention on the International Regulations for Preventing Collisions at Sea* opened for signature 20 October 1972, 1050 UNTS 16, Rule 5 (entered into force 15 July 1977).

221 Although the US Coastguard states outright that 'in all but the smallest vessels [including USVs], the lookout is expected to be an individual who is not the helmsman and is usually located in the forward part of the boat.' See Given the Coastguard specifically referred to unmanned craft in respect of that requirement, it is unclear whether that body feels USVs are not yet ready for autonomous operation or they simply missed the point. Clearly, like the civil aviation rules, approaches to sea traffic regulation may need some work. See US Coastguard, *When Do I Need a Lookout? Navigation Rules FAQ,* Department of Home Security <http://www.navcen.uscg.gov/mwv/navrules/navrules_faq.htm#0.3_12> (accessed 12 May 2010).

222 COLREGs, opened for signature 20 October 1972, 1050 UNTS 16, (entered into force 15 July 1977), Rule 3(g) defines restricted operations to include a range of routine maritime operations including: laying, servicing or picking up a navigation mark, submarine cable or pipeline; dredging, surveying or underwater operations; and minesweeping operations.

oblige UVs to clearly signal their status as not being under command or under restricted manoeuvrability. Should they 0fail to do so their operators might be held liable for any collision between them and another vessel, regardless of whether the other vessel was obeying the relevant rules.

More perplexing perhaps is whether or how an ocean-going UV would be expected to comply with the well established rule of international law that requires a vessel respond to a signal from a nearby ship that is in distress. For example, the 1979 *International Convention on Maritime Search and Rescue* (SAR) obliges vessels to 'retrieve persons in distress, provide for their initial medical or other needs' and 'deliver them to a place of safety.'[223]

This rule is repeated in many areas of maritime law, even in seemingly unrelated conventions such as the IMO *Salvage Convention* of 1989.[224] That Convention codifies an age old maritime law designed to provide incentive to ships nearby stranded or imperilled vessels to rescue and tow them to port by creating an automatic right of compensation against the owner.[225] Unlike the requirement to render assistance to persons, the Convention does not make rescue of vessels a *duty per se*, thus UVs would not be required to participate in such operations. Nevertheless, the Convention does present some problems for unmanned vessels. The question of whether a vessel should be salvaged is an objective one, determined according to whether a master has 'reasonable apprehension' that the vessel is sinking or will be damaged.[226] Roberts notes that current maritime practice is to 'consider unmanned vessels to be abandoned,'[227] which has led some authors to express concerns that mistaken fishermen or

223 *International Convention on Maritime Search and Rescue*, opened for signature 27 April 1979, 1405 UNTS 97, Chapter 1, [1.3.2] (entered into force 22 June 1985). This rule is reflected in the *United Nations Convention on Law of the Sea* (UNCLOS), which requires any ship of a party must 'render assistance to any person found at sea in danger of being lost; and to proceed to the rescue of persons in distress…' *United Nations Convention on Law of the Sea*, opened for signature 10 December 1982, 1833 UNTS 3, art 98(1)(a), (b) (entered into force 16 November 1994).

224 Article 10(1) states 'Every master is bound, so far as he can do so without serious danger to his vessel and persons thereon, to render assistance to any person in danger of being lost at sea.' *International Convention on Salvage*, opened for signature 28 April 1989, ATS 1998 No 2, art 10(1) (entered into force generally 14 July 1996).

225 James Nafziger, 'Historic Salvage Law Revisited' (2000) 31 *Ocean Development & International Law* 81.

226 See for instance: *Bureau Wijsmuller v United States*, 702 F.2d 333 (2d Cir. 1983); *Tidewater Salvage, Inc. v Weyehaeuser Co.*, 633 F.2d 1304 (9th Cir.1980).

227 Roberts, above n 16, 267.

masters who see un-crewed craft, floating apparently dead in the water may mistakenly tow them to a nearby port in order to collect salvage compensation.[228]

Of course, UVs would be perfectly suited to the 'dull, dirty and dangerous' nature of salvage operations.[229] One could foresee rescue ships, which linger in high-risk areas of the oceans, rendering assistance to distressed persons and towing stranded and sinking vessels to harbour for salvage. Such applications, and other uses of maritime UVs that cross through international waters, would need to work within the confines of the *United Nations Convention on the Law of the Sea* (UNCLOS). UNLCOS facilitates the free passage of vessels through the high seas and territorial seas of member states, so long as those vessels adhere to certain requirements.

Within the territorial sea, member states have complete sovereignty to dictate terms to foreign vessels, unless the passage of those vessels is 'innocent' and 'so long as it is not prejudicial to the peace, good order or security of the coastal State'.[230] Excluded from 'innocent passage' are a range of activities that may well be undertaken by UVs. These include: any exercise or practice with weapons of any kind; the launching, landing or taking on board of any aircraft or military device; fishing activities; and the carrying out of research or survey activities.[231] Similarly, UNCLOS may also restrict some common UV activities that would occur in contracting states' 200 nautical mile Exclusive Economic Zone, over which they hold sovereign rights to 'explore, exploit, conserve and manage natural resources, both living and non-living, within those waters'.[232] Also of note is the requirement that submersible vessels operate on the surface and display their flags whilst passing through the territorial

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228 See E D Brown, *Report on the Law Relating to Autonomous Underwater Vehicles*, Prelims of a Report commissioned by the Southampton Oceanography Centre, Society for Underwater Technology (London EC2R 5BJ) 147. Showalter and Manley argue that such a situation would not automatically result in salvage dues being paid, but rather it would shield the mistaken captain from liability and would be 'cold comfort to the operator who was unable to carry out the planned mission.' Stephanie Showalter and Justin Manley, 'Legal and engineering challenges to widespread adoption of unmanned maritime vehicles' Proceedings of *OCEANS 2009, Marine Technology for Our Future: Global and Local Challenges* (online) October 2009, 1-5, 26-29 <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5422108&isnumber=5422059> (accessed 25 May 2010).

229 UUV Master Plan, above n 112, 37.

230 *United Nations Convention on Law of the Sea*, opened for signature 10 December 1982, 1833 UNTS 3, art 19 (entered into force 16 November 1994).

231 Ibid.

232 Ibid, art 56.

sea.[233] This would require UUVs to surface if they are within twelve nautical miles of sovereign coastline, unless they have the permission of the relevant state to stay submerged.

The requirement that submersible vessels operate on the surface of territorial waters derives from the traditional assumption that submarines are ships of war. As UUVs expand into wider roles and become more autonomous, this assumption may not be completely accurate. Conversely, there may be many situations in which states may actually wish for their maritime UVs to be considered military vessels. That is because state ships on 'non-commercial' duties, and 'warships', enjoy a right of sovereign immunity from interference by other contracting states under UNCLOS.[234] This ensures that they such vessels cannot be seized, boarded or searched without the consent of the vessel's flag state.[235]

Given many UVs will in fact be deployed by navies or other military organs, or conversely contain highly valuable hardware, data or state secrets, it will be important for states that their UVs are granted sovereign immunity. However, whilst UNCLOS does not define what a state ship on 'non-commercial' duties is, it defines 'warship' as a vessel *inter alia* 'under the command of an officer' and 'manned by a crew which is under regular armed forces discipline'.[236] As we have consistently noted, the question as to whether a UV operating semi-autonomously is under command is debatable, however it seems relatively clear that such vessels will not be manned by a crew of any sort.

UVs will therefore challenge the limits of existing maritime law, just as the technology has in other environments. It is probable that the most immediate definitional problems, which affect naval states currently seeking to deploy such technology, will act as an impetus for the review of existing law in the interests of those states. The result may be a wider review of the laws applicable to non-military uses of maritime UVs. Regardless, it will be important for UV designers and deployers to be mindful of the existing legal regimes, and ensure that semi-autonomous vehicles respect the 'rules of the road'.

233 Ibid, art 20.

234 Ibid, arts 29-32, 95-96, 236.

235 Henderson, above n 17, 67.

236 *United Nations Convention on Law of the Sea*, opened for signature 10 December 1982, 1833 UNTS 3, art 29 (entered into force 16 November 1994).

8.3 UGVs on Public Roads

Whilst the potential for UVs mixing with civilian air and maritime traffic is very much a contemporary reality — indeed one arguably limited only by regulatory constraints in some instances — it is generally accepted that the integration of UVs into civilian motor traffic is some time off. Yet, as we have noted above, there has been a large amount of public R&D funding put into urban UGV applications, with some of the more optimistic proponents envisioning UGVs driving in civilian traffic as early as five years from now (2015).

Even if UGVs were ready for road use, road safety authorities around the world would have to be convinced that they could meet the generally strict safety conditions and traffic rules set out under domestic legislation in each jurisdiction. Unlike the aerospace and maritime environments, automobile laws are very much a domestic matter. This is in itself a regulatory impediment, as proponents will need to convince a large number of regulators that their vehicles are safe, and capable of respecting differing road rules. It is thus not possible to deal here with the legal issues that might arise from autonomous vehicles, except to make some general observations from our own common law system.

Within the common law context, road laws have always centred upon the liabilities and duties of the 'driver' of a vehicle. Importantly, the common law recognises that in certain circumstances, the driver may not be the person behind the wheel,[237] or even within the car.[238] Rather, who the driver is will largely be a question of fact, decided on a case-by-case basis. As Lord Widgery said in *R v MacDonagh*, '[t]he essence of driving is the use of the driver's controls in order to direct the movement, however that movement is produced.'[239]

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237 In *Anderson v Territory Insurance Office* [1999] NTSC 21, Bailey J posited that 'a vehicle passenger might be found [to be a driver] where the relevant act was, say, suddenly and without warning to apply the handbrake forcefully, grab the steering wheel or force the gear lever into reverse of a fast moving vehicle.'

238 For instance, someone pushing the vehicle from outside whilst holding the steering wheel was held to be an unlicensed driver in *R v MacDonagh* (1974) 1 QB 448.

239 (1974) 1 QB 448, 451. The main question is whether a person exercises 'some control over the movement and direction of the vehicle and generally [has] something to do with the propulsion': *Tink v Francis* [1983] 2 VR 17.

Moreover, the common law recognises that more than one person may be the 'driver' of any one vehicle,[240] even if the second 'driver' only exercised control — be it in lieu of, or with the other driver — for the shortest period of time.[241] Hence, the common law at least is open to the possibility of semi-autonomous vehicles, insofar as more than one 'driver' may be in control of the vehicle at different, or overlapping times and even that one of those drivers may not be physically located within the vehicle. However, like other forms of vehicle regulation, automobile law retains an anthropocentric focus.

Traffic law is premised on the assumption that the driver, upon whom it places duties and responsibilities in respect of other road users, is a 'person' in 'control' of the vehicle.[242] A person who allows any form of transport, be it mechanical or animal to operate without a driver on a public road, for however short a time, is therefore ordinarily considered to have committed an offense.[243] This would obviously present some problems for semi-autonomous or fully autonomous UGVs which, by their nature, would involve an individual allowing them to operate without a human driver. Whilst such legal impediments are not impossible to overcome, the idea of a 'person' being in control of a vehicle is so embedded in the common law system that it would require at minimum a large amount of regulatory review.

Such a review would clearly raise some novel legal questions. For instance, do UGVs need a driving license as human drivers do? Do their human controllers (assuming some or all are semi-autonomous) need to have a special license or will an ordinary license suffice? What about rules such as driving under the influence? Admittedly this isn't an issue for the UGV artificial intelligence itself, but is it appropriate to expect a human operator to have the same blood alcohol restrictions as a person located within, and in complete control of, a vehicle on the road? For that matter, how will fault be determined when a human and computer are sharing the reigns of a vehicle under traffic legislation? Indeed, who will be at fault if the

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240 See *Peter Francis Affleck* (1992) 65 A Crim R 96, which involved three separate people operating a motor vehicle, one in control of the pedals, another the gear stick and the third the steering wheel. Each were found to be drivers for the purpose of the relevant criminal law.

241 For instance, a passenger operating a handbrake. See *Mason v Dickason* [2006] ACTSC 102.

242 See for instance, *Road Traffic Act 1988* (UK) ss 1-5 (Driving Offenses); Part X (Road Rules), *Highway Traffic Act 1990* (Ontario); *Road Rules 2009* (Tasmania) s 16 ('Who is a driver').

243 See for instance, *Highway Act 1835* (UK) which prohibits: 'Riding upon the cart, or upon any horse drawing it, and not having some other person to guide it, unless there be some person driving it' and 'Quitting his cart, or leaving control of the horses.'

vehicle has an accident when it is clear only the computer AI was in control?

Legislators may find it necessary to make more explicit road rules which set out how a vehicle is to react in certain situations, that to date have only be considered in retrospect. Take, for example, a situation of a child on a bicycle darting out onto a busy suburban road. The human driver automatically swerves to miss the child, but in doing so hits a school bus, causing more fatalities than if they had continued on their ordinary path and hit the child on the bike. Should that driver be brought before a court, the court would consider what a reasonable ordinary driver would have done in those circumstances. Underpinning that objective decision-making process would be the understanding that a human placed in those circumstances would have reacted instinctively, unable to weigh up the various options. However, a sufficiently powerful computer system would be able to evaluate the various options in milliseconds and, if unable to avoid casualties, perhaps choose the path of least destruction. At that point it might seem obvious to choose the one life over the bus-full of lives, but what if the bus is not full of children, but convicted felons, or octogenarians, or the AI is simply unable to ascertain if there are *any* people on the bus (it could also be a UGV).

Should legislators not choose to set out rules for such eventualities, *someone* will have to, or at least provide the AI with sufficient guidance to make such decisions by itself. One would expect that the right body to make such value judgments would be a sovereign legislative body, not a software engineer. However, parliaments may find themselves uncomfortable with such questions, or indeed unable to adequately address the varying ethical dilemmas posed by prospectively deciding how to balance one set of lives with another.

9. *UVs and Civil Society*

Proponents of UV technology see the direct and indirect regulatory constraints as being some of the most significant barriers to the commercialisation of the technology. They have argued for a major review and clarification of existing civilian traffic safety regimes, and even the creation of a specific regulatory system for UVs.[244] As noted above, regulators remain cautious, but it is unlikely they will remain

244 Masutti, for instance, argues that UVs will 'have the potential to have as much, if not more of an impact on civilian life as it has military' but such applications have 'developed quite slowly due … to the lack of a regulatory frame- work.' She argues for urgent regulatory review of air law to permit UAVS to 'fly with other traffic out of segrated areas within national or international airspace'. Anna Masutti, 'Proposals for the Regulation of Unmanned Air Vehicle Use in Common Airspace' (2009) 34(1) *Air and Space Law* 1, 1.

so forever,[245] especially under the pressure of the potential 'avalanche of demand' for regulatory review.[246] Pressure is not just coming from the private sector; police and public agencies have expressed the desire to field UVs for a wide range uses. Indeed, as we have noted above, several public agencies have already taken the first steps towards integrating UVs into mainstream practice. These factors *in toto* suggest that regulatory barriers will come down in the near future. If proponents are correct, this will lead to a revolution in civilian affairs, just as it has in military ones.

Even if regulatory barriers to the commercialisation of drones are removed, legal and social issues will remain. Indeed, if we experience a civilian revolution similar to the military one, the commensurate explosion in applications and the massive technological, practical and cultural shift that occurs will challenge and potentially stretch contemporary laws and values. Whilst it is important to pre-empt such challenges so as to better regulate for them, such horizon scanning is beyond the scope of this paper. However, we would highlight a limited number of legal issues which can either be extrapolated from the military to civilian sector, or have already arisen as a result of limited use within that sector. These include the issue of fault; the question of privacy; how evidence gathered by UVs may be used; and how and when UVs may use force against humans. The last issue is very much a general one — indeed it simply mirrors the military debate that using UVs will distance those using them from the use of force, and may make them more willing to use force or less proportionate in the use of that force. This will need to be dealt with by each community and each police force. Whilst the same can be said for the other legal issues, it is worth discussing them in more detail as it is arguable that UVs challenge existing legal systems' capacity to effectively achieve the core purpose and policy behind each law. Again, we discuss these from a common law perspective, although these issues may cross jurisdictional boundaries.

9.1 Tort, Negligence and the Question of Fault

As we noted above, UVs, especially UAVs, have proven reasonably unreliable and subject to faults, errors and accidents. As an embryonic technology, such problems are understandable and it is likely scientific and engineering advances will improve their reliability; at least to a point that regulators are willing to allow such vehicles to share domestic traffic space. Of course, that does not mean that UVs will be free of faults. Their introduction into civilian zones will no doubt result in some 'teething problems'. Equally, the exponential growth in the technology is likely to result in increased

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245 'Lightweight drones poised for take-off', *Oxford Analytica Daily Brief Service*, 13 January 2010, 1; see also Stafford, above n 165.

246 Karp and Pasztor, above n 209.

numbers of UV applications becoming operational, each with their own unforseen risks.

In many respects, tort law is adequately equipped to deal with UVs. The tort of negligence, for instance, imposes a duty on anyone along the causal chain to exercise a minimum level of prudence. Regardless of how autonomous a UV is, there will always, ultimately, be human agents that can potentially be held responsible. They would include: software and hardware developers; manufacturers; systems engineers; operators; and those who decide to deploy them, or set the parameters for their deployment. The law of negligence requires that each of these people take reasonable care to avoid or reduce the likelihood of foreseeable harm arising from the ultimate use of that UV.

Negligence also permits multiple tortfeasors to be attributed responsibility as it recognises that one or more people along the causal chain may have contributed to the harm, and attributes fault accordingly. That is particularly important as the complexity of UV systems means that a fault may have multiple causes: within the software or hardware; with respect to the way that humans operate that hardware or software; or indeed how the system operates within real-world parameters, especially with respect to unforseen or unexpected events. Equally likely is that a fault might arise out of a combination of these things. For instance, a fault in the AI's programming might be compounded by a commander's decision to release it without sufficient safety testing and or due to a lack of human oversight.

However, determining fault in complex software and hardware is already difficult.[247] Given that UVs require systems which are increasingly complex and powerful,[248] the ability of negligence to reach into the maze of complexity and extract a responsible party is likely to be limited. Moreover, it is limited by salient considerations of causal, physical and circumstantial proximity which seek to place a reasonable constraint on unfair or burdensome duties being imposed on those who are simply too far removed from the act that caused harm.[249] It is unlikely that a court would impose liability on a computer programmer whose small piece of code — possibly designed for much more general purposes than being used in a UV — caused an unforseen conflict within a massive code library, resulting in a UV that acts in an unpredictable or dangerous way.

247 John C Munson, Allen P Nikora and Joseph S Sherif, 'Software Faults: A Quantifiable Definition Source' (2006) 5(37) *Advances in Engineering Software* 327.

248 Bruce T Clough, 'Unmanned Aerial Vehicles: Autonomous Control Challenges, A Researcher's Perspective' in Robert Murphey and Panos M Pardalos (eds), *Cooperative Control and Optimization* (2002) 35.

249 *Janesch v Coffey* (1984) 155 CLR 549, 414 (Deane J).

This may be a hypothetical determination at the extremities of the fault matrix however, as UVs become more autonomous, various components of their creation and use are likely to become more distant,[250] and therefore the question of fault more remote.

Thus, the common law is not incapable of dealing with new technologies such as drones. However drone technology is still likely to create some real challenges to those charged with determining liability in tortious claims. Indeed, as UV systems become more complex and more powerful the benchmark may become higher and the common law may need to develop tests to adequately attribute fault. Whilst damage has been caused by drones operating in segregated airspace over civilian areas, such claims have so far been resolved outside of the legal system.[251] Realistically, it may be some time before such issues come before the courts, and sufficient jurisprudence has developed to determine whether the current tort of negligence is adequate.

10. *Privacy*

Perhaps a more immediate question is how the civilian transition of this technology, developed to provide global, persistent surveillance in a war zone will affect privacy law, which is already under pressure from surveillance technology and anti-terror policing.[252] As we noted above, police forces around the world, particularly in the UK and US, have been keen to use UAVs to monitor and detect criminal activity. The UK police have also used small tactical drones equipped with thermal imaging cameras to pursue suspects.[253] However, there is a concerted effort by many forces to move beyond small tactical UVs towards more persistent and widespread surveillance. As we set out above, police in the UK plan to use UV

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250 Robotic and computer engineers have long tried to reach the 'holy grail' of 'evolutionary computation' that is, computing systems which learn from basic principles and are able to program themselves or other systems. See Michael S Mahoney, 'Software: The Self-Programming Machine' in Atsushi Akera and Frederik Nebeker (eds), *From 0 to 1: An Authoritative History of Modern Computing* (2002) 91. Some recent examples can be found at on the following websites: 'Robots learn to move themselves' *BBC News* (online) Wednesday 6 August 2008 <http://news.bbc.co.uk/2/hi/technology/7544099.stm> (accessed 26 May 2010); 'Computer Software that Writes Itself' *Newsweek* (online) 26 December 2005 <http://www.newsweek.com/2005/12/25/computer-software-that-writes-itself.html> (accessed 26/5/2010).

251 John Adley, 'Fears after UAV crash-landing' *Carmarthen Journal* (Wales) 30 October 2009, 1.

252 Jed Rubenfeld, 'The End of Privacy" (2009) 61(1) *Stanford Law Review* 101.

253 Paul Lewis, 'Eye in the sky arrest could land police in the dock' *The Guardian* (UK) 16 February 2010, 1.

technology to provide round-the-clock monitoring of the 2012 Olympics, as well as surveillance of public spaces to detect illegal activity. US police forces have similarly moved to adopt drone technology for traffic and criminal surveillance.[254] In contrast to the excitement shown by some police forces,[255] civil rights and privacy advocates have expressed severe reservations about what they see as 'Orwellian' technology permitting the persistent surveillance of individuals without their knowledge or consent.[256]

Concerns about privacy are not new, but then again, neither are concerns about negligence or targeted killings; it is similarly a matter of degree and scale. As in these other areas, the concern about drones is how they may facilitate increasingly broad ranging, invasive and covert monitoring by the state, and possibly private companies and individuals. Small and micro drones, which are already deployed by police departments, 'can be outside your window and you won't hear a whisper'.[257] Medium altitude UAVs will be able to monitor vast areas of land from relatively undetectable spots. Further, all forms of UVs will be able to be fitted with sensors that can see through darkness, dust, walls and even clothing.[258] Unlike current surveillance systems, which tend to involve fixed, visible camera systems in public spaces, UVs will provide highly mobile and generally undetectable surveillance of any area within the relevant jurisdiction. Current UV applications

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254 McBride, above n 1, 637.

255 So much excitement in some cases like that of the abovementioned arrest, that they have operated the drones without regulatory approval.

256 See, '*Fact Sheet on U.S. "Constitution Free Zone"*' (2008) American Civil Liberties Union <http://www.aclu.org/technology-and-liberty/fact-sheet-us-constitution-free-zone> (accessed visited 25 May 2010); Calo, M Ryan, 'Robots and Privacy' in Patrick Lin, George Bekey and Keith Abney (eds), *Robot Ethics: The Ethical and Social Implications of Robotics* (forthcoming), available at <http://ssrn.com/abstract=1599189> (accessed 2 June 2010); Declan McCullagh, 'George Orwell, here we come', *CNET News* (online) 6 January 2003, available at <http://news.cnet.com/2010-1069-979276.html> (accessed 25/5/2010); Mary Kaldor, 'Old Wars, Cold Wars, New Wars, and the War on Terror' (2005) 4(42) *International Politic*s 491.

257 Joby Warrick and Peter Finn, 'Amid outrage over civilian deaths in Pakistan, CIA turns to smaller missiles' Washington Post (online) Monday, 26 April 2010 <http://www.washingtonpost.com/wp-dyn/content/article/2010/04/25/AR2010042503114_2.html?sid=ST2010042503646> (accessed 4 June 2010).

258 The US Government is funding 'passive millimetre wave technology' which can be mounted onto mobile systems to allow controllers to view through clothing to detect whether a person is carrying contraband or weapons. It has been suggested that the technology could be fitted to UVs. See William Stewart, 'Passive Millimeter Wave Imaging Considerations for Tactical Aircraft' (2002) *IEE AESS Systems Magazine*, 11.

could easily permit a person to be watched as they travel from home to work without their knowledge. Without some constraint, it is possible that covert surveillance will be ubiquitous in the not too distant future.

Whether the law should permit the more persistent and widespread surveillance that UVs provide is a matter of public policy. As McBride states 'some people may welcome the introduction of additional technology that may catch or decrease criminal activity' whilst 'others are significantly more apprehensive about the widespread use of such technology.'[259] However, unless there are regulatory constraints on the use of this technology, those wishing to challenge the legality of the use of UVs for surveillance may find it difficult to do so.

Privacy is protected by a wide range of international and domestic laws. Article 17 of the *International Covenant on Civil and Political Rights* (ICCPR), perhaps the most prominent international human rights treaty, obliges member states to protect their citizens against interference or attacks against the right to freedom due to 'arbitrary or unlawful interference with his privacy, family, home or correspondence.'[260] The right to privacy enshrined under the ICCPR is reflected in supranational conventions such as the *European Convention on Human Rights* (Art 8(1)) and the *American Convention on Human Rights* (Art 11(2)),[261] both of which adopt similar terminology to that found in the ICCPR.

Despite such rules, privacy is notoriously hard to protect. In part this is because it is somewhat of an esoteric concept, without precise objectively discernable boundaries. More to the point, privacy is a right that must necessarily be balanced against other rights, such as freedom of expression and the ability to interact with others in the community without fear of arbitrary or unfair prosecution. Indeed, common law courts traditionally viewed privacy as a matter for individuals to protect themselves. Hence, in the seminal Australian case of *Victoria Park Racing*, Latham CJ summarised the traditional view as being that 'the law cannot by injunction in effect erect fences which the Plaintiff is not prepared to provide.'[262] Instead, the role of the common law was limited to ensuring that the 'fences' so erected were not illegitimately torn down or circumvented by others.

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259 McBride, above n 1.

260 These words are adopted from the earlier *Universal Declaration on Human Rights 1948* (art 12).

261 *American Convention On Human Rights*, opened for signature 22 November 1969, 1144 UNTS 123, (entered into force 18 July 1978).

262 Victoria Park Racing and Recreation Grounds Co Ltd v Taylor (1937) 58 CLR 479 (Latham CJ).

Whilst some existing tortious laws, such as trespass, might prohibit UVs from entering private property, their ability to exclude unwelcome surveillance from outside the property is limited. Aerial surveillance that does not amount to a nuisance (something discrete low altitude drones are generally designed not to do), would also be outside the scope of trespass. The common law has historically precluded the space below and above private property from being actionable in trespass.[263] The doctrine of confidentiality would also be limited due to the lack of a 'reasonable expectation' of freedom from aerial and transborder viewing by ordinary members of the public (something that is dealt with below under the US tort of privacy). This leaves individuals with little in the way of actionable rights against UVs that are used to survey their private property.

UV technology thus renders the traditional common-law assumption — that privacy can be protected by the individual — a fallacy. UAVs in particular, undermine this assumption, unless one expects individuals to literally box themselves in to avoid the prying eyes from above. Interestingly, US courts, which recognise privacy as a tort in its own right,[264] seem to have suggested as much. The US tort of privacy is not absolute and can only be relied upon to protect the 'reasonable expectation' of privacy. Thus American courts have permitted aerial surveillance of property by police on the grounds that the owner could not have reasonably expected that an ordinary member of the public cannot view the property from a private aeroplane.[265] In *Florida v Riley*, the Court found that provided an ordinary member of society would be permitted to fly over and observe the plaintiff's land, the claim to a right to privacy from aerial surveillance was not one that 'society is prepared to honour.'[266] Conversely, a person who intentionally obscured their land with netting (so as to avoid detection for illegal drug growing) from aerial

263 *Lord Bernstein of Leigh v Skyviews & General Ltd* [1978] QB 479, in which the court held that the only space above the land which was protected by trespass was that which was 'necessary for the ordinary use and enjoyment of the land and structures upon it'. Aerial vehicles were generally excluded. In *United States v Causby*, 328 U.S. 256, 261 (1946) the Supreme Court ruled that the sky was a 'public highway' and landowners could not bring property based torts with respect to it.

264 In that country the protection against unlawful surveillance is something that conflates both actionable privacy and the constitutional protection against an unlawful search in the fourth amendment to the US Constitution. See generally McBride, above n 1.

265 In *California v Ciraolo*, 476 U.S. 207 (1986), 209 the Court determined that the reasonable expectation of privacy was whether the 'naked eye observation of the curtilage by police from an aircraft lawfully operating … violates an expectation of privacy that is reasonable.' The answer in that case was no, as the observations in question 'took place within public navigable airspace' (at 213).

266 *Florida v Riley*, 488 U.S. 445 (1989), 447–448.

view was protected from police surveillance under the principle.[267] In other words, a person must literally build fences, which protect themselves from unwanted observation from all three spatial dimensions.

Further, the Court also considered whether the surveillance was carried out by means available to the common person.[268] Thus the protection would be invoked where surveillance was carried out using high-powered cameras or specialised aerial craft that would not be available to an ordinary member of the public.[269] This has led academics such as McBride to argue that UAVs would possibly infringe the reasonable expectation of privacy, given their covert, specialised and restricted nature.[270] That is because ordinary members of the public could not expect to operate such craft, and could not expect others in society to be able to obtain the highly detailed surveillance data they provide. Yet, there are problems with this argument insofar as the technology will become increasingly accessible to public and private sector organisations and individuals.

As we have set out above, UVs are also likely to become important tools for non-surveillance activities such as surveying, mapping, hazard detection and so-on. Popular publically available internet-based mapping tools such as Google Maps,[271] or Microsoft's Terra Server,[272] already provide high resolution images of public and private space collected from satellite, aerial and ground vehicles. Given the suitability of UVs for global, persistent surveillance, they would seem the most appropriate craft to carry out such mapping in the near future. Even before that, however, it is questionable whether it is reasonable to expect that private property will not be viewed by specialised technologies, or that the data collected by these devices will not be available to members of the general public.

It may be argued that the distinction between data feeds from UVs and those found on public mapping software are that the former are real-time, whereas the latter are archived footage collected from manned or unmanned platforms. Nevertheless, it is unlikely that an ordinary person could tell when a satellite or aeroplane passing over their property is collecting data. As such, no person can reasonably expect that at one moment or another they, or their property are not being monitored from the ground, the air or outer-space. The second problem is that it is increasingly possible for individuals to obtain

267 *Dow Chemical Co. v United States*, 476 U.S. 227 (1986), 234-35.

268 *Florida v Riley*, 488 U.S. 445 (1989), 447-448, 455.

269 Ibid.

270 McBride, above n 1, 552–654.

271 See Google Maps, <http://maps.google.com> (accessed 6 June 2010).

272 See Terraserver, <http://www.terraserver.com/> (accessed 6 June 2010).

live, or close to live data-feeds. Small drones can easily be constructed for less than US$1000 and retrofitted with popular videophones to provide near live video feeds overlapped on top of Google Maps.[273] For those unable or unwilling to construct such a system themselves a French company now offers a more expensive commercial mobile videophone mountable drone system capable of being fitted with infrared and thermal imaging cameras.[274] The availability of such devices, demonstrates that a person cannot reasonably expect their property to be immune from live-feed surveillance by other members of the community. Assuming the technology becomes more available and less expensive the reasonable expectation argument will become even harder to mount.

Further, the reasonable expectation of privacy test is rarely extended to public spaces. If it is, it is only applied where an ordinary member of society would find the use of the information gathered 'highly offensive'. Hence in the US case of *United States v Knotts*, the Court held that an individual 'travelling in an automobile on public thoroughfares has no reasonable expectation of privacy', even when tracked by invisible means.[275] Similarly, the UK's wide-scale use of public surveillance has survived a number of legal challenges in the European Court of Human Rights (ECtHR),[276] although the UK has been labelled the 'most surveilled' country in the western world.[277]

Although the ECtHR has been keen to reduce state infringements of privacy in public spaces, most of its emphasis has been on protecting individuals against arbitrary or unjustified invasion of their private space, or the dissemination of inherently personal information to the

273 In 2008, a group of academics from the University of California Santa Cruz, constructed a small UAV from inexpensive (less that US$1000) commercially available products and fitted it with a Nokia N95 video phone. The UAV was able to patrol coordinates from Google Maps and 'successfully [take] aerial pictures, on average, every four seconds'. They concluded that, 'the presentation of the pictures and the mosaics in Google Earth proves to be very useful to analyze the received pictures.' Mariano I Lizarraga *et al.*, 'Aerial Photography using a Nokia N95' (Proceedings of the World Congress on Engineering and Computer Science, 22–24 October 2008, San Francisco, USA). Details on the construction of inexpensive UAVs are available online. See <http://www.soe.ucsc.edu/classes/cmps290b/Fall07/UAVImageRegistration/NewSite/index.html> (accessed 28 May 2010).

274 See Pict Earth, <http://www.pictearth.com/services.html> (accessed 6 June 2010).

275 In that case, through the use of an electronic beeper. *United States v Knotts* 460 U.S. 276 (1983), 283.

276 *Kennedy v The United Kingdom*, [2010] Eur Court HR 682 18 May 2010; *Perry v United Kingdom*, (2004) 39 EHRR 76, 17 July 2003.

277 'Britain is "surveillance society"' *BBC News* (online) 26 November 2006, <http://news.bbc.co.uk/2/hi/uk_news/6108496.stm> (accessed 22 October 2010).

public, rather than its collection *per se*.[278] The ECtHR thus requires that the state prove that surveillance was conducted in accordance with law, pursued with a legitimate aim, and necessary in a democratic society.[279] However, the Court gives a relatively wide latitude to states in determining what aims are legitimate, particularly if respective parliaments have approved them and so long as some form of internal rules or guidelines have been established to ensure they are overseen by a competent legal authority.[280] Moreover, Article 8 of the *European Convention on Human Rights* has been interpreted as protecting a 'reasonable expectation' of privacy,[281] thereby raising the same problems as found under the US privacy model.

As we have discussed above, privacy issues are not new, it is simply that UVs compound the problem and stretch the existing law to an extent that many may feel uncomfortable with. The slow march of legal reform, especially judicially driven legal reform, is often left behind by the rapid progress of technology and the consequent social changes. The success of UVs in the military environment is due primarily to their ability to provide high-powered and constant surveillance over vast tracts of land. Their adoption into the civilian world will provide the same surveillance capacities to those controlling them; capacities far beyond those envisioned by the courts of both those countries that recognise a right to privacy and those that do not.

10.1 Use of Evidence

Should UVs be accepted as a legitimate part of state surveillance and law enforcement, further questions might need to be asked about how the evidence gathered by such vehicles may be used in criminal and even civilian trials. Novel information gathering techniques can promise more than they actually deliver, and the perception of scientific inviolability amongst prosecutors, judicial officers and

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278 See for instance, *Weber and Saravia v Germany*, (App. 54934/00), Decision of 29 June 2006; *Sciacca v Italy*, (App. 50774/99), (2006) 43 EHRR 400, 11 January 2005. In *Perry v United Kingdom* the Court said that 'the normal use of security cameras *per se* … where they serve a legitimate and foreseeable purpose, do not raise issues under Article 8(1) of the Convention'. See *Perry v United Kingdom*, (2004) 39 EHRR 76, 17 July 2003, 40.

279 *Klass and others v Federal Republic of Germany*, (1979-80) 2 EHRR 214, 6 September 1978, [43-60].

280 *Weber and Saravia v Germany*, (App. 54934/00), Decision of 29 June 2006, [104]; *Klass and others v Germany*, ibid, [37]; *Liberty & Others v the United Kingdom* ECHR, (App No. 58243/00), 1 July 2008.

281 Murray v Express Newspapers plc and another [2008] EWCA Civ 446; Wood v Commissioner of Police for the Metropolis [2009] EWCA Civ 414 (21 May 2009).

juries can result in miscarriages of justice.[282] The recent recoil from the unquestioning use of DNA evidence in some jurisdictions is a prime example of this.[283] In Australia for instance, a 2010 report by former Justice Frank Vincent which examined the infamous wrongful conviction of a rape suspect based on DNA evidence concluded that: 'DNA evidence appears to have been viewed as possessing an almost mystical infallibility [and] … [p]erceived as so powerful by all involved … that none of the filters upon which our system of criminal justice depends to minimise the risk of a miscarriage of justice, operated effectively.'[284]

Drones have largely arisen from the annals of science fiction, and the potential for their mystique to overwhelm the filters of criminal justice is equally strong as it has been in other technological revolutions. Despite their mystique, drones feeds' are not completely reliable; they are often grainy and of low resolution. Infrared, heat or other sensors mounted on UVs may be even more unreliable. The multiple examples of mistaken targeted killings, discussed above, are testament to the potential unreliability of UAV surveillance data.[285] Conversely, of course, UV data may be utilised to provide more probative weight to circumstantial evidence, for example by showing a person fleeing from the scene of an alleged crime.

In April 2010, the first police arrest using a drone was undertaken in the UK. In that instance, the police followed a stolen vehicle from which two individuals exited into heavy fog.[286] A small UAV with

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282 See Frank Vincent, C*onviction of Mr Farah Abdulkadir Jama* (Report by Former Justice Frank Vincent into the Circumstances that led to the Conviction of Farah Jama), Victorian Department of Justice, Melbourne Australia, May 2010 ('Vincent Report').

283 Law Institute of Victoria, 'DNA Evidence Alone Should not be Enough for Conviction Says LIV' (LIV Media Release) 6 May 2010 <http://www.liv.asn.au/About-LIV/Media-Centre/Media-Releases> (accessed 28 May 2010); Michael Lynch *et al*, *Truth Machine: The Contentious History of DNA Fingerprinting* (2008); Joy Russell 'Uses and limitations of DNA profiling in forensic investigations' (2009) 7 *Victorian Institute of Forensic Medicine Review* 6. Conversely, see Robyn Blewer and Lynne Weathered, 'Righting wrongful convictions with DNA innocence testing: proposals for legislative reform in Australia' (2009) 1(11) *Flinders Journal of Law Reform* 43.

284 Vincent Report, above n 282, 11.

285 See also, 'US reprimands six over deadly air strike in Afghanistan', *BBC News*, (online) 29 May 2010 <http://news.bbc.co.uk/2/hi/south_asia/10189462.stm> (accessed 29 May 2010).

286 Simon Boyle, 'Merseyside Police "drone" fails to convict suspected car thief', *Click Liverpool* (online) 28 April 2010 <http://www.clickliverpool.com/news/national-news/128901-merseyside-police-drone-fails-to-convict-car-thief.html> (accessed 25 May 2010).

infrared sensors was deployed to follow one of the suspects through the fog. Despite arresting the suspect, a UK magistrate dismissed the charge on the grounds that the infrared images were not sufficient evidence that the suspect was actually driving the stolen vehicle at the time. Whilst the case is from an inferior court, and the magistrate in question rejected the infrared footage as not being probative, it does suggest that rules relating to the use of such evidence might need to be created, especially in relation to jury directions.

11. *Commercialisation or Proliferation?*

Perhaps the biggest legal challenge in respect of the commercialisation of UV technology is the question of how to respond to the transition of military systems into the private sector and their transfer to third states. As Beard notes, military advances, especially by technology rich superpowers like the US, are driven by a consistent belief that scientific and industrial progress will guarantee both military supremacy and success at war. Yet, as he points out, the 'fundamental belief in the power of military-technological achievements' does not come with a commensurate consideration of, or deliberation about, the long-term implications those developments will have.[287] Beard cites a range of unintended consequences arising out of the unconstrained development of military technology, including 'the proliferation of new weapons in the hands of enemy states or non-state actors, resulting changes in the ways wars are waged, commercial spin-offs of technologies that were once monopolized [sic].' These are relevant considerations for UVs, both in respect of their commercialisation and in terms of their proliferation.

11.1 UVs as Weapons

UVs are not *strictly* weapons, insofar as they may have a range of uses, and carry a variety of onboard systems which have non-military utility. Conversely, they are extremely capable weapons platforms and are increasingly being designed to take the place of manned fighter craft.

In this context, the first question that needs to be addressed is whether the commercial sale of drones should be restricted or licensed. Relatively inexpensive UVs of all types can already be constructed from hobby kits and fitted with weapons, including a new generation of recoilless gun that are being designed specifically for small-unmanned systems.[288] A significant proportion of the

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287 See Beard, above n 50, 411.

288 See Recoilless Weapons Program, Tactical Aerospace Group <http://www.tacticalaerospacegroup.com/news.html> (accessed 25 May 2010).

community,[289] and academics,[290] believe there is some connection between violent video games, and violent episodes including massacres. Thus, it is arguable that such military-derived systems represent a danger in the wrong hands, particularly when they are available to adolescents. That invokes the question of whether UVs of all types should be subject to weapons-style restrictions, and if so, at what level. UVs are obviously useful for domestic and agricultural use and restricting their availability could potentially limit those beneficial uses. However, there is precedent for such a system in countries with strict gun laws, such as Australia, where farmers are permitted to use guns and rifles for specific purposes, whilst other members of the community are not.

11.2 UVs as Vehicles for WMDs

Equally, we have learnt from the attacks on the US in September 2001 that a vehicle can be used as a weapon. In that case the aeroplanes were manned, but made incredibly effective surrogate 'missiles'. There is functionally little difference between a long-range UAV and a modern cruise missile that can be reprogrammed mid-flight.[291] Medium altitude UAVs can fly great distances, for up to two days without refuelling, whilst small UAVs can be deployed from within major urban centres.

Whilst UAVs are certainly smaller than the jets flown into the World Trade Centre towers, military analysts have expressed their concern that 'even very small planes carrying an extra large fuel tank in place of a pilot could do significant damage in an urban setting.'[292] Further, the large storage compartments that replace a cockpit can easily be fitted with explosives or other dangerous materials.[293]

289 Ronald Burns and Charles Crawford, 'School shootings, the media, and public fear: Ingredients for a moral panic' (1999) 2(32) *Crime, Law and Social Change* 147.

290 C A Anderson, 'An update on the effects of playing violent video games' (2004) 27(1) *Journal of Adolescence* 113; Kaveri Subrahmanya *et al* 'The Impact of Home Computer Use on Children's Activities and Development' (2000) 10(2) *The future of children: Children and computer technology* 123, 132–134.

291 Matthew Hutchins, 'Drone Wars: Experts ponder implications of remote, robotic warfare', *Harvard Law Record* (online) <http://www.hlrecord.org/news/drone-wars-experts-ponder-implications-of-remote-robotic-warfare-1.1265443> (accessed 28 May 2010).

292 Dennis M Gormley, *Unmanned Air Vehicles as Terror Weapons: Real or Imagined?* (July 2005) Center for Nonproliferation Studies Report, Monterey Institute of International Studies <http://www.nti.org/e_research/e3_68a.html> (accessed 21 April 2010).

293 Ibid; see also Richard A Muller, 'The Cropdusting Terrorist' (March 11, 2002) *Technology Review*.

Indeed, UVs are recognised as being particularly suited to asymmetrical warfare. As early as 2002 — just as US was beginning to utilise UVs *en masse* — the US Acting Deputy Assistant Secretary for Non-proliferation warned a Senate subcommittee that 'there is a potential for terrorist groups to produce or acquire small UAVs and use them for CBW (chemical and biological weapons) delivery.' [294]

With the increasing proliferation of the software and hardware systems required to construct UVs, the ability to carry out such attacks will become increasingly easy.[295] Military analysts agree that there is little in the way of conventional defence against either form of terrorist attack,[296] leading the *Centre for Non Proliferation Studies* to argue in 2005 that, 'terrorist use of UAVs deserves a greater degree of attention than it receives today.' The Centre went on to argue, however, that the issue could be solved before such a group obtained weapons because: '[a]chieving successful autonomous flight of a UAV is a daunting task for any terrorist group … It would require at least two years of determined effort and some level of outside or foreign assistance.'[297]

Ironically, less than a year later Hezbolla, a guerrilla force listed by many countries as a terrorist organisation, flew four drones across Israel in the 2006 Israel/Lebanon conflict.[298] Whilst these UAVs were not weaponised, they nevertheless alarmed the military community because they showed how accessible this equipment had become and how technologically adept insurgent groups are. However, the only surprising thing is that such an attitude of technological arrogance still exists. Insurgents, terrorists and asymmetrical

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294 Acting Deputy Assistant Secretary for Nonproliferation Vann Van Diepen told a Senate subcommittee on 11 June that UAVs are potential delivery systems for weapons of mass destruction, and 'there is a potential for terrorist groups to produce or acquire small UAVs and use them for CBW (chemical and biological weapons) delivery.' See Senate Committee on Homeland Security and Government Affairs, *Testimony of Vann Van Diepen Acting Deputy Assistant Secretary of State for Nonproliferation Provided to the Senate Governmental Affairs Subcommittee on International Security, Proliferation and Federal Services*, 11 June 2002, 1.

295 See Gormley, above n 292; see also Eugene Miasnikov, *Threat of Terrorism Using Unmanned Aerial Vehicles: Technical Aspects* (Center for Arms Control, Energy and Environmental Studies, Moscow Institute of Physics and Technology, 2005).

296 Gormley, above n 292 argued that it 'is impossible to conceive of an affordable and highly effective nationwide defense against these low-flying threats'.

297 Ibid.

298 We do note however, that Gormley cited two incursions by Hezbollah into Israeli airspace the previous year. See Gormley, above n 292; see also Levinson, above n 31.

fighting groups have proven themselves incredibly adept at using technology to aid their cause, even to the extent of hacking into coalition drone feeds over Afghanistan and Iraq so as to avoid detection.[299]

11.3 The UV Arms Race

It has been suggested that it was Iran, which provides material support to Hezbolla, that played a pivotal role in that groups ability to deploy the UAVs. Iran has an active UV program,[300] something that worries western nations, especially due to the ever-present concern about its nuclear intentions. Iran is not alone, a wide range of states are involved in UV development and deployment including Belarus, Georgia, India, Pakistan and Russia.[301] In fact, more than forty countries now have UV programs and the competition between these countries for market and technological dominance is

299 In 2007, the US military revealed that drone feeds in the US and Afghanistan had been intercepted by insurgents using mobile phone hacking software freely available on the internet for as little as US$26.00. Although the insurgents were not able to control the drones, they were able to monitor the images the drones were sending back to their controllers in real-time, thereby alerting them to which parts of the country were being monitored by the military and which were not. The military admitted that the feeds had been left unencrypted on the assumption that the insurgents would not be technologically capable or willing to intercept the data feeds. See Yochi J Dreazen, August Cole, and Siobhan Gorman. 'Officers Warned of Flaw In U.S. Drones in 2004', *Wall Street Journal eastern edition* (New York, New York) 18 December 2009, A.1; Siobhan Gorman, Yochi J Dreazen and August Cole, 'Insurgents Hack US Drones – $26 Software is Used to Breach Key Weapons in Iraq; Iranian Backing Suspected', *Wall Street Journal eastern edition* (New York, New York) 17 December 2009, A.1. In fact, insurgents operating in Afghanistan and Iraq, along with other conflict zones have proven both technologically adept and capable of utilising off-the-shelf technologies to respond to and countermand cutting edge military hardware. It is therefore plausible that, in some future conflict zone an enemy may not only be able to intercept drone feeds, but actively alter them — for instance to show looped video of a surveillance area to mask the movement of vehicles through that area — or even to hijack drone controls.

300 'Iran to make "advanced" attack drones' *The Telegraph* (UK); Waleed Ibrahim and Missy Ryan, 'U.S. forces shot down Iranian drone: Iraq official' *Reuters News* (online) 16 March 2009, <http://www.reuters.com/article/idUSTRE52F2ZL20090316> (accessed 12 May 2010).

301 P W Singer, 'Defending Against Drones: How our New Favourite Weapon in the War on Terror Could Soon be Turned Against Us', *Newsweek* (online) 8 March 2010 <http://www.newsweek.com/id/234114> (accessed 15 March 2010).

increasing.[302] Singer estimates that in 2010, 'two thirds of worldwide investment in unmanned planes ... will be spent by countries other than the U.S.'[303] The ability of UVs to undertake dull, dirty and dangerous work and to transfer risk from soldier to robot are as attractive to these countries as they are to the US, Japan and Israel. Yet there is little doubt that the need to keep up with these market leaders is also driving an unspoken arms race towards the roboticisation of military forces worldwide.

We have previously raised some concerns about UVs' potential to increase complacency about military operations and as a consequence increase the likelihood of governments entering into them.[304] Indeed, it is undeniable that the ability to enter into conflict without the same human or political cost as your opponent provides a distinct military advantage. Drones are likely to feature heavily in future battlefield operations, even to the extent that whole drone fleets may battle each other. A battle between UV forces would require each combating party to have equal amounts of, and equally powerful hardware, software and communications systems. Those drones that are able to 'think', react, manoeuvre and engage quickly in the field of conflict will be more successful than those that are slower. Moreover, once an opponent's UVs are removed, that side must either choose to replace its robots with humans, or capitulate. The obvious consequence of this is an already apparent race towards technological dominance in robotic technology, while on the periphery other nations race to roboticise their militaries.

If the race towards UV superiority evokes memories of the cold war, so does the concern raised by commentators such as Sparrow, that UAVs may result in the build-up of 'loitering' UAVs on state borders. Sparrow argues that this would increase tension and hostility amongst nations, and because UAVs make it possible to maintain a 'permanent armed presence' on the borders of states, it may serve to increase the risk of accidental war.[305] According to Sparrow this is due to two factors. First, to counteract the threat posed by 'loitering' UAV fleets, states would have an incentive to have their own forces mobilised and ready to respond to an attack. Second, it would provide targets with 'very little time' to ascertain whether or not they are actually under attack.[306] The downing of a Georgian UV by the Russians, and of an Iranian drone by US forces

302 The market leaders in UV technology are the US, Japan and Israel, with France following closely behind. See UVS International, *UAV Categorisation, in Yearbook: UAVs Global Perspective* (2004) 156.

303 Singer, above n 301.

304 See also Sparrow, above n 136, 26.

305 Ibid, 27.

306 Ibid.

on the Iraqi border are evidence that such build-ups are already beginning.

11.4 Unthinkingly Towards Autonomy

We argued above that UV proliferation may well result in an arms race towards technological dominance in robotic technology. A secondary, related consequence of such an arms race is a steady march towards UV autonomy. Although drones can undertake many routine operations unsupervised, all current applications of the technology, military or otherwise, require some degree of human involvement, be it for initial flight planning or the decision to target a suspect. In this respect, UVs at this stage are semi-autonomous (as defined above). The basis for this is twofold: first, because processing power and artificial intelligence is not yet sufficiently developed to allow reliable high level decision-making; and secondly because there is some reluctance to hand over such decisions to a fully autonomous machine. However, there are several factors militating towards these machines becoming increasingly autonomous in the future.

11.4.1 Smarter Machines

It is important not to overstate the level or capacity of drone artificial intelligence. However, with technology advancing rapidly, the distinction between fully autonomous, and semi-autonomous drones will diminish.[307] Computing technology has doubled in power and capacity about every eighteen months since its inception. This exponential trend, known as 'Moore's law' was first observed over five decades ago and has proved relevant to a wide range of computing technologies, from processing power to memory and sensor arrays — all of which are fundamental to UV operation. Moore's law also applies to artificial intelligence, indicating that it should surpass many aspects of human intelligence in the next 10-20

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307 Much of what drones already do requires highly complex computing power and a degree of artificial intelligence. Although many of the functions which are left to human controllers are described as 'complex', 'vital' or 'important', the reality is that much of what drones do requires highly complex computational power. Drones in current operation can already maintain flight paths, react to changes in weather and visibility, and even detect and follow targets in the absence of direct control (see US OSD Roadmap, above n 8). Drones have also been programmed to detect and alert controllers to a wide range of activity such as suspicious roadside activity that might indicate the planting of a roadside bomb or, in a domestic setting, speeding vehicles and fly tipping. All of these operations are highly complex, vital and important and require powerful computational calculations and reflect a skill level that would ordinarily take a human years to achieve.

years.[308] At this juncture the question will not be *if* we can provide UVs with full autonomy, but whether we are willing to.

11.4.2 Economic and Force Factors

As Nardi argues, economic pressure during times of financial restraint encourage technologies which allow commanders to get more work done with fewer humans involved.[309] The more autonomous a UV, the less oversight is needed and the greater the saving. Yet the desire for more autonomous vehicles is as much about providing militaries with more effective force multipliers as it is about cost cutting. If only one human controller is required to oversee twenty drones by one side, whereas each drone on the other requires a dedicated controller, all other things being equal, it is clear which side has the military advantage.

11.4.3 Emergency and Offline Response

Remote, teleoperational and semi-autonomous UVs all require some link between machine and controller. This link is a prime target for interception, jamming and 'digital warfare'. Drones already utilise redundancy protocols to return to base when communication links are severed. However, it is likely that in future digital warfare scenarios, drones may be programmed to become fully autonomous and defend themselves in the case of an attack. In fact, communication links can and already have been hacked.[310] This raises the possibility that hackers may be able to confuse UVs, or even reprogram them. Thus in high technology battles it is arguable that it may become more advantageous to remove the remote human from the equation, or at the very least enable a UV to defend itself when that link is severed.[311]

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308 We recognise that the estimates of computers exceeding human intelligence vary widely. However, there are many decision making aspects of artificial intelligence that are likely to exceed human capacities in this period, for instance, the ability to detect and respond to enemies, to set strategies and react to threats etc. See generally Hans Moravec, 'When will computer hardware match the human brain?' (1998) 1(1) *Journal of Evolution and Technology* (online) <http://www.jetpress.org/volume1/moravec.htm> (accessed 12 January 2010).

309 Nardi, note 30, 6, 42.

310 See Dreazen et al, above n 299.

311 Beyond these systems, the US Military has committed itself to developing UVs capable of 'complex tactical behaviors with minimal required operator control or intervention during a mission' but also 'autonomously respond to threat attacks detected by its integrated countermeasures suite … sense the attack with no human aid and make the appropriate response.' Capability Development Document for the Future Combat Systems, quoted in Nardi, above n 30, 18, 19.

11.4.4 Speed and Response Supremacy

As we stated above, in UV combat, success will rely as much on speed and processing power as it will on numerical superiority or firepower. The machine that can detect, target and successfully engage another machine will prevail. A machine that can operate without human oversight will clearly be faster and have near-instantaneous decision making. Whilst many UV proponents are insistent that a human will always 'be in the loop', if one state proceeds with full autonomy, others will likely feel the need to follow suit. Indeed, fixed autonomous defence systems already exist.[312] This has set the precedent for machines controlling their own weapons systems. Whether further automation is something the global community is willing to accept is uncertain, although we would hazard to say that many in the community may feel uncomfortable with it. As Singer states, many people are afraid of the machine that 'wises up and then rises up'. Conversely, others argue that armed machines will make much more ethical warriors, insofar as they 'will not fall asleep, get scared, or react emotionally.'[313]

12. *Are Current Laws Sufficient?*

The previous section raised some potential implications of increasing use of, reliance on and proliferation of UV technology. Namely, (1) the concern that UAV technology, in particular, could fall into the hands of terrorist groups or 'rogue' nations and be used with devastating effect. This concern is heightened when it is considered that UAVs could easily be used as vehicles to launch WMD; (2) the fact that the rush to secure the latest UV technology could well trigger an arms race, increasing both the ease with which countries

312 Fully autonomous weapons systems are already used in limited situations from fixed points. For instance, Korean border defense systems can detect and autonomously fire at humans attempting to breach the demilitarised zone. The US use the PHALANX system onboard ships and from ground positions to defend against incoming threats such as missiles or mortars; it can also operate fully autonomously.

313 Nardi, above n 30, 4. While some argue that a robot should never be allowed to use lethal force, others see the outcome as inevitable and therefore belies an obligation to set the precedent in a responsible manner. Dr Ronald Arkin, Regents' Professor and Director of the Mobile Robot Laboratory at Georgia Institute of Technology, was hired by the US Army Research Office to conduct research concerning embedding ethical behavior into autonomous UMS. Dr. Arkin's 'research hypothesis is that intelligent robots can behave more ethically in the battlefield than humans currently can.' 'Robot May be More Humane Soldier', *International Herald Tribune* (online) 26 November 2008 <http://www.military.com/news/article/robot-may-be-more-humane-soldier.html?col=1186032310810> (accessed 15 May 2010).

can decide to go to war, and the risk of accidental war; and finally (3) the plethora of issues that are raised by the use of fully autonomous weapons systems and other fully autonomous UVs, which promise to substantially change common conceptions of war, law enforcement and many other areas. We consider that such issues, that are by no means trivial, deserve at a minimum deliberations both at the community level, and on the international plane.

There are currently few domestic laws dealing with the development of artificial intelligence or drone hardware. More importantly, the authors are aware of no international laws or treaties relating specifically to the development of drones. There are, however, some international agreements that may affect the transfer or acquisition of UV technology.

12.1 Missile Technology Control Regime (MTCR)

This agreement is of some relevance to the discussion on UAV proliferation. The MTCR is an 'informal and voluntary association which share the goals of non-proliferation of unmanned delivery systems capable of delivering weapons of mass destruction.'[314] The MTCR has thirty-four countries as partners, and 'rests on adherence to common export policy guidelines applied to an integral common list of controlled items.'[315] The MTCR lists two categories of items: category one covers 'complete unmanned aerial vehicle systems capable of delivering at least a 500kg payload to a range of at least 300kms.'[316] In relation to category I items, the MTCR provides that 'particular restraint will be exercised in the consideration of... transfers regardless of their purpose, and there will be a strong presumption to deny such transfers.'[317] Category II items consist of equipment and other technology that may contribute to Category I items. There are 'several levels of rules' that apply to the transfer of Category II items, depending on the capacity of the relevant item to contribute to the development of the Category I item.[318]

Gormley and Speier have pointed out, however, that the MTCR is a 'policy' and as such cannot supersede a treaty under international law. They thus argue that the MTCR's rules do not restrict transfers required by treaties, such as that establishing NATO or treaties

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314 See generally, Missile Technology Control Regime Website <http://www.mtcr.info/english/index.html> (accessed 15 May 2010).

315 Ibid.

316 Missile Technology Control Regime, Equipment, Software and Technology Annex, MTCR/TEM/2009/Annex/002 (2009), Category I, Item 1.A.2, <http://www.mtcr.info/english/annex.html> (accessed 10 April 2010).

317 Ibid, Guideline 2.

318 Gormley, above n 292

within the European Community.[319] Further, the MTCR is merely an export control regime, and therefore does not limit the development, or production of such weapons. The MTCR regime also does not cover the increasing use of UAVs in combat roles, such as targeted strikes, or for surveillance, but is limited to a nexus with WMDs.[320]

12.2 The Wassenaar Arrangement

The Wassenaar Arrangement is also a multilateral export control regime which seeks to impose guidelines on the transfer of conventional arms and dual-use goods and technologies, thereby preventing 'destabilising accumulations.'[321] Under the Wassenaar Arrangement, participating states are required to provide specific information on any decision to transfer or the denial of transfer of any UAV that is designed, modified, or equipped for military use.[322] UAVs are also mentioned in Appendix 3 of the Arrangement, which requires states to control all listed items with the 'objective of preventing unauthorised transfers or re-transfers of those items.'[323] Gormley and Speier argue that the controls found in the Wassenaar Arrangment are 'not nearly as tight as the MTCR controls', as they 'basically involve only a requirement to conduct export reviews and to make international notifications.'[324] However, the Wassenaar Arrangement covers a more extensive category of UAVs than the MTCR as it is not limited to vehicles with a particular range or payload.

12.3 Other Non-Proliferation Treaties

The US Department of Defence (DoD) in their 2001 UAV Roadmap suggested that various other arms control treaties could impact on

319 Ibid.

320 Ibid.

321 Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies ('Wassenaar Arrangement'), Introduction <http://www.wassenaar.org/introduction/index.html> (accessed 6 July 2010).

322 Ibid, Initial Elements, Part II Scope (3). Unmanned Aerial Vehicles are listed in Appendix III, Specific Information Exchange on Arms: Content by Category (4). See Wassenaar Arrangement, <http://www.wassenaar.org/guidelines/docs/Initial%20Elements%20-%202009.pdf> (accessed 12 April 2010).

323 Wassenaar Arrangement, Initial Elements, Part III Control Lists (1). Unmanned Aerial Vehicles are listed in Appendix 5 under both the Munitions List (ML10) and the List of Dual-Use Goods and Technologies (Category 9.A.12). See Wassenaar Arrangement, <http://www.wassenaar.org/guidelines/docs/Initial%20Elements%20-%202009.pdf> (accessed 12 April 2010).

324 Gormley, above n 292.

their ability to initiate modifications of existing reconnaissance UAVs to permit them to deliver ordnance, or to develop new UCAVs.[325] As examples of treaties that may apply, they listed the 1987 *Intermediate-range Nuclear Forces Treaty* (INF); the 1990 *Conventional Armed Forces in Europe Treaty* (CFE); and the 1991 *Strategic Arms Reduction Treaty* (START). Gormley and Speier have stated that they 'cannot pinpoint any current controversies regarding the treatment of armed UAVs and UCAVs by these treaties' and that 'it is not at all clear that the treaties will ultimately restrict armed UAVs or UCAVs.'[326]

As the discussion above indicates, we consider that there are good reasons to restrict at least the proliferation of UV technology, if not its development and usage. Clearly, the current international legal regimes that attempt to curb the proliferation of some UV technology are not particularly strong, and not specific to UV technology. Further, they do not have a particularly wide ratification or scope. It is also clear that the UV revolution will not be an easy one to control. Unlike nuclear weapons, UV technology is not particularly complex or inaccessible, nor is it currently limited to a handful of countries. As discussed, much UV technology is already commercialised and widely available. To a great extent the horse has bolted on restricting the proliferation of UV technology. However, given that current UVs have not yet become fully autonomous, and only a few countries are actively using the technology in combat, there may still be time to create an effective legal regime.

13. *Conclusion*

Despite existing for millennia, unmanned vehicles have, up until very recently, had little impact on the internal or external aspects of the societies using them. As such, little or no law existed specifically to deal with UVs in civilian or military life. Indeed, we could find no domestic or international laws directed at UVs. Of course, things have changed; UVs now play a dominant role in military affairs and are likely to have a dramatic impact on various civilian sectors in the near future.

Despite lying dormant for such a long period of time, UVs rapidly came of age in the last decade. The use of UVs has exploded and continued to grow in an almost exponential manner. We are, as a number of commentators have noted, at the dawn of a UV

325 Office of the Secretary of Defence, *Unmanned Aerial Vehicles Roadmap 2000-2025*, (April 2001) Section 6.4.3 Treaty Considerations.

326 Dennis Gormley and Richard Speier, 'Controlling Unmanned Air Vehicles: New Challenges', Paper Commissioned by the Non-Proliferation Education Center, 19 March 2003, <http://www.npec-web.org/files/Essay030319%20Controlling%20Unmanned%20Vehicles%20-%20Gormley%20and%20Spei.pdf> (accessed 16 April 2010).

revolution. It is a revolution that shows no signs of slowing down. This is in part due to dramatic advances in computing, communications and hardware which have made UV systems a viable alternative to manned ones. Yet this is only part of the reason for their success; the reality is that a combination of social, political and military factors have created the perfect environment for UVs to prosper in. Perhaps the most important of these has been the paradigm shift in global conflict from direct engagement between state parties, to transboundary asymmetrical conflicts between states and non-state actors following the terrorist attacks on the US in 2001.

UVs meet a number of demands created by the post 2001 military paradigm, not least their ability to provide global, constant surveillance. They also improve sensor-to-shoot cycles and target accuracy; undertake dull, dirty and dangerous roles; and act as force multipliers. Such traits cater to the increasingly political nature of warfare, in particular the desire to reduce domestic troop casualties and the challenges of securing funding for overseas engagement during times of fiscal restraint. In sum, UVs allow humans to move further and further away from the zone of conflict, but have increasing amounts of influence over it.

Many have said UVs are changing the nature of war, yet it is probably more appropriate to say that UVs have prospered because of the changing nature of warfare. Conversely, that prosperity means that UVs are now much more accessible to, and utilised by the military and as a result, the previously unconventional roles they are suited to have become much more mainstream. Hence, surveillance, reconnaissance, rapid engagement and targeted killings have all moved from the periphery of military operations — that is, operations undertaken by covert or special forces — to become common tools of war. Laws do exist to regulate such activities, but they were created at a time when there were practical or political limitations, which served to limit their wide scale use. For instance, targeted killings required a large deal of resources, planning and risk taking. Similarly, gathering intelligence or conducting surveillance over other states required highly complex and expensive clandestine operations that could go catastrophically wrong if exposed.

The same is true on the other side of the conflict. The increasing availability of UV technology may actually serve to facilitate asymmetric warfare and terrorism. No longer do humans have to be trained, educated or indoctrinated (depending on your point of view) to undertake suicidal missions against more powerful enemies. UVs have the capacity to be much more proficient asymmetrical fighters and terror machines.

The use of UVs therefore circumvents many of the social, political and practical limitations upon the commissioning and undertaking of various forms of non-conventional warfare. The question is whether we need to expand or review existing laws to fill in the gaps now that those normative control structures no longer exist. Unfortunately, the horse has already bolted, so to speak, and any discussion of regulatory review will be limited by the pragmatic reality that UVs are now firmly entrenched in military practice. That is not to say that the march of UVs should continue unabated. There is still a chance to at least shape the way UVs are used and how far they proliferate within militaries and beyond. However, the technology is advancing rapidly and it would seem important to have that debate sooner rather than later, otherwise it may be no more than an exercise in rhetoric and futility.

There is perhaps more of an opportunity to have pre-emptive regulatory dialogue about the impact of UVs on the civilian world. Ironically, one of the primary reasons they have not had the same impact in the civilian as military sector is due to regulatory uncertainty, especially in the medium altitude aerospace environment. If, or more appropriately, *when*, those regulatory hurdles are overcome, UVs may also have revolutionary consequences for many commercial and public sector operations. Like the military arena, UVs will not create new legal issues, so much as challenge the limits of existing legal regimes. Certainly the law will need to respond to a new form of intelligence — that is, robotic, rather than human — for the first time in history. What is perhaps more important however, is consideration of how the machines designed for military purposes might be used by states and corporations against citizens.

UVs promise many benefits for civilian life but we must not forget that they were born in the theatre of war. Although they have begun to transition to the civilian sector they still retain many of their military characteristics. Indeed, many current civilian UVs are simply military robots retrofitted and rebadged. More to the point, the characteristics, which made them so popular with military commanders, are also the ones which make them attractive to governments and corporations. These include the ability of UVs to extend the oversight and the reach of their controllers, as well as to amplify their influence.

Whilst existing laws do protect individuals from state incursions, these laws are limited by the minds of their creators, who drafted them when governments and corporations were only as powerful and as limited as the human agents that acted for them. UVs will serve as force amplifiers for these bodies, and also allow them to have a much more persistent and profound influence over the daily lives of ordinary citizens. We would argue that those citizens should be provided the opportunity to debate the impact of these new technologies and consider whether existing laws will adequately protect the principles they are designed to uphold in the face of the robotic revolution. Such a debate should happen in advance of, rather than subsequent to, the wide-scale introduction of UVs into civilian life. That way, debate will inform the scope of the use of UVs in that sector, rather than the other way around.

There is one aspect of UV technology which we feel creates some unique and novel legal, social and ethical issues. That is the question of autonomy; specifically, whether machines should ever be provided full autonomy to undertake activities which can cause harm to humans. Realistically we are probably still a long way off from full autonomy. We say 'probably' because it is obvious that UV advancement has snowballed in terms of the technology but also applications and deployment have taken place much quicker than anyone could have anticipated. Moreover, despite continued assertions that humans will always be in control of some aspects of UV operations, the only guarantee of this at present seems to be rhetoric rather than reality.

Many of the forces driving UV development seem to be militating toward increasing their autonomy. Indeed, without some form of restraint it would seem that the only natural result of the UV arms race is to create machines that are not encumbered by human controllers. Yet there is, as of yet, no restraint. If that process continues unabated we may find ourselves in a situation not that dissimilar to the global position on nuclear weapons we find ourselves in today. The world lives in fear of such weapons, considering their use reprehensible, but cannot eradicate them because few states are willing to accept the power imbalance created by the others having them.

Realistically, once one nation has fully autonomous UVs the others will follow. That situation may be fifty years away, or it may be five, but ultimately, now is the best time to have the debate about whether the world community is willing to accept such a future. We cannot say decisively that citizens and states would be unwilling to hand over weapons autonomy to machines. In many respects robots would, in fact, make more ethical soldiers, calmer policemen and more rational security officers. We would, on the other hand, hazard to guess that many people would be uncomfortable and hostile to such an eventuality. Each side of the debate should be heard and citizens of the world given an opportunity to make a meaningful decision which can inform an international, legal response. Given the nature of technology and commercialisation that would, we argue, be the only effective way of ensuring an effective and consistent outcome. We hope that the next special edition of this Journal will be a suitable springboard for such discussion.

Unmanned Vehicles: A (Rebooted) History, Background and Current State of the Art

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Abstract

This introductory overview is an update to the original précis paper in JLIS vol 19(1) by Gogarty & Hagger. It provides a contemporary summary of unmanned technology in use at the time of publication. Legal analysis and commentary from the original précis has been removed. Comments and responses by authors in this edition should be taken to refer to the original précis paper.

1 *Introduction*

In this paper we will examine the current state of unmanned vehicle (UV) technology. We will begin by defining the key terms of art relating to UV technology. We will subsequently set out a brief history of UVs, prior to the turn of the century and then consider why their use has exploded following it.

1.1 Definition and terms

There is, as of yet, a lack of consistency in the nomenclature and taxonomy of unmanned vehicles. As with the précis we will utilise the following acronyms, recognising they are not universally accepted. Expert commentators in this edition have also adopted the following terms.

1.1.1 Common acronyms, synonyms and key terms

- UVs: Any vehicle which operates without a human in direct physical contact with that vehicle.
- UV variants: The four acronyms used to describe UVs operating in different environments are UAVs (unmanned aerial vehicles), UGVs (unmanned ground vehicles), USVs (unmanned [water] surface vehicles), and UUVs (unmanned underwater vehicles).
- UCV variants: Refers to weaponised UVs. UVs designed specifically for this purpose usually include the term 'combat' within the acronym; hence a UCAV is an unmanned combat aerial vehicle.

- Drones: The term 'drone' is arguably the most common and widespread synonym for UVs. In particular it is used to refer to unmanned aerial vehicles (UAVs).[1]

- Remote vehicles[2]: These generally refer to vehicles over which a human has direct, albeit remote, control. For instance a human operator receives visual images from cameras or sensors on-board a UV and steers it by cable (tethered control) or wireless signal (remote control). This form of human/machine interface is referred to as 'teleoperated' control.

- Robotics: The more autonomous forms of UVs are often referred to as robots or robotic systems. The Oxford English Dictionary (OED) describes a robot as 'a machine … designed to function in place of a living agent, esp. one which carries out a variety of tasks automatically or with a minimum of external impulse'.

1.1.2 Autonomy

UVs vary in their form and complexity, but perhaps the most important distinguishing feature, especially for the purposes of this article, is the degree to which a UV can operate without human control and direction.

Modern UVs are all 'controlled' to one degree or another; however modern technology platforms and 'artificial intelligence' (AI) give drones the capacity to function without direct human intervention. UAVs in current use can, for instance, be set general patrol coordinates and then left to pilot themselves; while surveillance UGVs can independently patrol long stretches of border, only alerting a human controller when suspicious activity is detected.

Due to this increasing level of independence, UVs are often referred to as 'autonomous vehicles'. However, it is clear that, at present, no drone in active military or commercial use is actually 'autonomous', in the sense that they are completely independent or self-governing. In this edition we will continue to maintain a distinction between 'semi-autonomous' and 'fully autonomous' drones.

Semi-autonomous drones are given broad operating instructions by operators, but are left to carry out routine functions within those parameters, such as navigation or monitoring operations. Critical decisions, such as whether to fire weapons or follow a suspect target off routine patrol paths are currently left to a human operator to veto or directly control. In this respect military

1 Indeed, the Oxford English Dictionary describes a drone as 'a pilotless aircraft or missile directed by remote control.'

2 Other common terms used to describe UVs include Remotely Piloted Vehicles and Remotely Operated Vehicles.

officials sometimes describe this form of artificial intelligence as 'supervised autonomy'.[3]

Fully autonomous drones would not require such a human veto. Rather, they would be given general instructions and then left to fulfil their directives according to their programming and artificial intelligence. In this way a fully autonomous drone would be akin to a soldier who is given a general directive — for instance, 'secure that hill' — but, apart from observing general rules of engagement would be left to fulfil the mission according to programming.[4]

2 *The Historical Use of Unmanned Vehicles*

As we stated above, unmanned vehicles are by no means a novel technology. Ancient civilisations are known to have built a variety of unmanned craft, even flying ones.[5] Although some of these may have simply been for science or spectacle, more often than not ancient UVs were used to provide advantage on the battlefield. In that arena, unmanned vehicles were seen as advantageous as they could, on the one hand, maximise the influence over the zone of conflict whilst, on the other hand, minimise exposure of personnel to the risks created by the conflict.[6] This trend continued into the mechanisation

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3 John Keller, *The time has come for military ground robots* (2010) 20(6) *Military & Aerospace Electronics* <http://www.militaryaerospace.com/index/display/article-display/363893/articles/military-aerospace-electronics/volume-20/issue-6/features/special-report/the-time-has-come-for-military-ground-robots.html> (accessed 10 March 2012).

4 According to the UN Special Rapporteur on Extrajudicial, Summary or Arbitrary Executions, Philip Alston, '[a] number of countries are already reportedly deploying or developing systems with the capacity to take humans out of the lethal decision-making loop.' One such autonomous robotic system is an unmanned watchtowers deployed by Israel on the Gaza border, armed with machine guns that locates targets and 'transmits information to an operations command centre where a soldier can locate and track the target and shoot to kill.' Future plans include a Watchtower that will remove human intervention from the identify/target/shoot process. A similar system is being used by South Korea in the demilitarised zone and has reportedly been 'equipped with the capacity to fire on its own.' See Philip Alston, *Interim Report of the Special Rapporteur of the Human Rights Council on Extrajudicial, Summary or Arbitrary Executions*, UN Doc A/65/321, (23 August 2010) 15.

5 The ancient Greek engineer Archytas is said to have invented the first UAV, a mechanical pigeon, in the 4th Century BC. It was recorded as having flown some 200 meters. Kimon P Valavanis, *Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy* (2007).

6 Hence, the vast majority of early R&D in unmanned vehicles was directed towards gathering surveillance from, or delivering payloads to, high-risk territory. The Greeks and Chinese, for instance, set unmanned ships on fire and steered them into their enemies' fleets to cause panic and destruction or break their formation. Chinese generals also made use of kites for military reconnaissance. In 200 BC, the

of war following the industrial revolution; indeed some of the first machines to enter onto the modern battlefield were UVs.[7] Yet, despite being involved in most major armed conflicts from that period to the turn of the millennium,[8] the impact of UVs on the conflict zone — with some notable exceptions by the Israelis[9] — was rather minimal.[10]

Chinese General Han Hsin of the Han Dynasty was said to have flown a kite over the walls of a city he was attacking to measure how far his army would have to tunnel to reach past the defences. See Michael John Haddrick Taylor and David Mondey, *Milestones of Flight* (Jane's, 1983); Kenneth S Smith Jr, *The Intelligence Link – Unmanned Aerial Vehicles and the Battlefield Commander* (1990) GlobalSecurity.org <http://www.globalsecurity.org/intell/library/reports/1990/index.html> (accessed 2 March 2012).

7 Including unmanned surveillance balloons that dropped explosives on enemies (patented in 1863), remotely controlled torpedoes (1866) and aerial kites equipped with cameras remotely controlled by a long string to take surveillance photos of enemy positions and fortifications (1898).

8 See Office of the Secretary of Defense (US) *Unmanned Aircraft Systems Roadmap 2005 – 2030*, (2005) k-1, ('US OSD Roadmap').

9 During the 1980s, the Israeli air force successfully used UAVs to detect, and draw fire from, Syrian anti-aircraft batteries, allowing manned jets to then remove the threat. Following this success, Israel expanded its drone program, placing extensive resources into the novel technology and how it could be integrated into combat systems and strategy. By the turn of the century Israel was using a range of UVs to provide Intelligence, Surveillance and Reconnaissance (ISR) data from, or adjacent to dangerous enemy territory that could be provided via up-to-the-minute feeds to commanders, air support, battle units and strike teams. See Adam Stulberg, 'Managing the Unmanned Revolution in the U.S. Air Force' (2007) 51(2) *Orbis* 253.

10 Although the German V-1 bombs that terrorised London during the late part of WWII are often cited as the first successful UAV attack, we would not consider them either true UAVs in the modern sense, nor truly 'successful'. Whilst the technology behind V-1s was, at the time, groundbreaking, it was not capable of providing a significant advantage over traditional, manned vehicles. In part this was because the systems were too costly to operate both in terms of real costs but also in terms of payload efficiency: only about one quarter of V-1s were to hit their targets, with the remainder failing. V-1s are simply single use, single target 'terror weapons' which 'lacked precision guidance'. The guidance problems that plagued V-1s would also be a problem for post-war UAVs. These problems included short duration aloft and communications limitations, which required a line-of-sight to the UV or at the least close proximity to it. Whilst this was acceptable in non-conflict arenas, for instance where the drones were used as test targets, the limitation undermined one of the main advantages of UV technology, that is, removing humans from the area of risk. See Bill Yenne, *Attack of the Drones: A History of Unmanned Aerial Combat* (Zenith Press, 2004) 19; see also, Daren Sorenson, *Preparing for the Long War: Transformation of UAVs in Force Structure Planning for Joint Close Air Support Operations* (2006) Joint Forces Staff College (US) 14–15, <http://en.scientificcommons.org/35201347> (accessed 12 March 2012).

A number of factors might account for the sidelining of UVs from mainstream combat roles during the twentieth century. One is the lack of support by some operations planners and military commanders, due to the unproven, untested and initially unreliable technology.[11] Early UVs did however prove successful within aerospace reconnaissance, decoy and target roles;[12] which made them popular with the intelligence community. However, that meant that much of the research and development in the area was highly classified,[13] and as such it is hard to determine just the number of UVs deployed to conflicts and covert operations.[14]

2.1 Non military roles

UVs tended to have an even smaller role outside of the military. The main exceptions to this general rule were within exploratory UUVs and agricultural UAVs.

The oceans are relatively uncluttered and do not require highly complex navigation. This made early UUV development easier.[15] UUVs proved useful in undersea mapping, and later in wreck detection and submarine rescue.[16]

11 As Goebel states: 'The whole idea of reconnaissance drones seemed to be completely dead, but at the last moment the USAF rescued the program. One of the interesting themes in defence programs is how new military systems are often initially proposed in grand terms, with whizzy features and the latest technology. When the grand plan proves too complicated and expensive, the military then backtracks, finally ending up with a much more modest solution, often a minimal modification of an existing system. Interestingly, such compromise solutions often prove far more effective than expected.' See Greg Goebel, *Unmanned Aerial Vehicles* (2010) 'The Lightning Bug Reconnaissance Drones' v2.0.0 [3.0], <http://www.vectorsite.net/twuav.html> (accessed 01 March 2012).

12 Where they were not required to undertake complex navigation to avoid obstacles or hazards, and therefore did not require a large amount of command and control and therefore were less susceptible to jamming or spoofing. See Goebel, ibid.

13 Although Newcome postulates that part of the reason that information about drone use in conflicts like the Vietnam War was suppressed was a fear that it would affect the livelihoods of human fighter pilots by creating a push towards the roboticisation of the air force. See Laurence Newcome, *Unmanned Aviation: A Brief History of Unmanned Aerial Vehicles*, American Institute of Aeronautics and Astronautics (AIAA) (2004) 67–69.

14 UVs featured in conflicts such as the Vietnam War (see US OSD Roadmap, above n 8, p k-1) although it is clear that they did undertake important surveillance and decoy missions. See Newcome, ibid, 69.

15 G N Roberts, 'Trends in Marine Control Systems' (2008) 32 *Annual Reviews in Control* 263.

16 Indeed UUVs — albeit tethered versions — gained a great deal of public attention during the 1990s with the discovery and exploration of undersea wrecks like the Titanic, the Lusitania, and the Bismarck, which could only have been made possible through robotic UV systems. In fact, the first 'golden age' in UV technology occurred under the oceans more than a decade before it did in the air.

Obviously these roles had a naval/military utility, yet they also were important for other sectors, particularly marine research and the resource industry. Despite such vehicles being unmanned during this period, the reality was that most commercial, research and military UUVs were 'tethered' to a human operator and could not truly be said to be semi-autonomous.[17]

Another exception to the military focus of UV development has been in aerial spraying of agricultural crops, in particular by the Japanese who trialled unmanned helicopters as early as the 1950s.[18] Although early UVs were initially more like a remote controlled vehicle, by the turn of the century Japanese rotary-wing UAVs were advanced enough to navigate to pre-programmed routes without direct human oversight, and undertook tasks such as crop spraying, agricultural monitoring or scientific mapping.[19]

2.2 UVs in the 21st century

The latter part of the 20th century saw the advent of the 'digital revolution', which resulted in dramatic advances in computing processing power, sensor technology and satellite telecommunications.[20] These technical developments permitted a commensurate evolution in UV independence and autonomy and by the turn of the century, technology was sufficiently advanced to generate

See Andrew Henderson, 'Murky Waters: The Legal Status of Unmanned Undersea Vehicles' (2006) 53 *Naval Law Review* 55, 57.

17 Roberts, above n 15, 266.

18 With commercial use starting in the 1970s. See Mark Peterson, 'The UAV and the Current and Future Regulatory Construct for Integration into the National Airspace System' (2006) 71 *Journal of Air Law and Commerce* 521, 546.

19 Ibid.

20 Satellite technology seems to have played a large part in drone development. Before reliable satellite imagery could be obtained, drones were attractive as low risk alternatives to manned fly-overs of risky territory. However, as satellite imagery became more reliable and of better resolution it was favoured over drones as a much less provocative way of collecting intelligence data: see Goebel, above n 11, ch 5. Other factors which contributed include: central processing units aboard UVs were much more powerful and could effectively manage a wider range of functions that were previously required human oversight; Roboticisation and miniaturisation meant that previously manual controls could be handed over to the central processing unit; Digitisation and miniaturisation made for lighter, more efficient vehicles, which could be deployed for longer periods and over longer distances. The efficiency gains permitted a wider range of on-board sensors to be installed. Improvements in sensor technology allowed a much wider spectrum of visual and non-visual data to be collected at a higher resolution than before. Digital compression overcame previously detrimental information 'bottlenecks' and permitted much more of this data to be transmitted to the controller. For information on the 'digital revolution' see generally, Stephen Hoare, *Digital Revolution (20th Century Inventions)* (Raintree, 1998).

real interest in deploying UVs outside of covert military operations.[21] However, it was perhaps the terrorist attacks in September 2001 in the United States that served as the most important catalyst for the adoption of UVs as a key counterinsurgency tool. Of particular note is the ability of UVs to provide global, persistent surveillance; reduce the sensor-to-shoot cycle; and undertake dull dirty and dangerous roles. These factors are discussed in greater detail below.

2.2.1 *Catalysts for the UV revolution: 'Global Persistent Surveillance'*

The terrorist attacks on the US in 2001, led to the so-called 'war on terror', and a decisive shift in the military strategy of the US and its allies. As its name suggests, the war on terror is one waged against asymmetric opposition — usually small groups, or even individuals, who may be dispersed, highly mobile and located in remote locations.[22] The US response to these challenges was, in part, a policy of 'global persistent surveillance' which aimed to 'deny enemies sanctuary by developing capabilities for persistent surveillance, tracking, and rapid engagement'.[23] This refocussing of US strategic and military policy shifted intelligence, surveillance and reconnaissance (ISR) operations from the periphery of covert operations to the centre of regular military engagements.[24] The result was increased demand, funding and research into platforms that could undertake consistent, wide-scale, and high-powered ISR duties.

2.2.2 *Catalysts for the UV revolution: sensor to shooter cycle*

A characteristic of the war on terror has been the disparity in logistical, technological and numeric strength between the US, and the armed groups opposing it. Those opponents have adopted an asymmetric response, involving the use of decentralisation, force dispersion, concealment, ambush techniques and the ability to quickly disappear into remote locations or amongst civilian populations.[25]

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21 See Peter Van Blyenburg and Philip Butterworth-Hayes, 'UVS International Status Report on US UAV Programmes' in *2005 Year Book: UAVs Global Perspective* (2005) 112.

22 Anthony Cordesman, Center for Strategic and International Studies, 'The Lessons of Afghanistan: War Fighting, Intelligence, and Force Transformation' (2002) 26.

23 Donald Rumsfield, quoted in ibid.

24 R Ackerman, 'Persistent Surveillance Comes into View' (2002) *Signal Magazine*, 18.

25 See, Steven Metz and Raymond Millen, I*nsurgency and Counterinsurgency in the 21st Century: Reconceptualizing Threat and Response* (2004) Strategic Studies Institute (SSI) monographs <http://handle.dtic.mil/100.2/ADA428628> (accessed 5 April 2012); Frank Hoffman, 'Complex Irregular Warfare: The Next Revolution in Military Affairs' (2006) 3(50) *Orbis* 395, 395–407; Mark Clodfelter 'Airpower versus Asymmetric Enemies – A Framework for Evaluating Effectiveness' (2002) 16(3) *Air*

Countering asymmetric warfare has required that conventional forces adopt a similar level of speed and versatility. In traditional warfare there is often a significant lapse between detecting and engaging an enemy, commonly referred to as the 'sensor-to-shooter cycle'.[26] Reducing the sensor-to-shooter cycle was a major concern for the conventional forces operating in the post 2001 middle-east conflicts. The longer the delay, the higher the chance the enemy would either disappear into countryside or urban areas, or mount a surprise attack or ambush.[27]

2.2.3 Catalysts for the UV revolution: dirty, dull and dangerous

The growth of UV technology has also been attributed to their propensity to undertake 'dull, dirty and dangerous' roles.[28] As a result, UVs have become extremely popular amongst military and governmental planners and decision makers. This is not least because of the highly politicised nature of modern warfare and the belief amongst administrators and strategists that the public has a low tolerance for domestic troop casualties in foreign conflicts.[29] Furthermore, troop management and efficiency are extremely important in modern military operations, which have become increasingly focused upon 'winning the peace' after the initial 'shock and awe' tactics have moved resistance into the hills or into the cities of conflict zones.[30] Stabilisation requires resources on the ground to patrol civilian areas for threats, and to increase troop engagement with local populations to help build trust and

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and Space Power Journal 37; Montgomery C Meigs, 'Unorthodox thoughts about asymmetric warfare' (2003) 33(2) *Parameters*, 5-6.

26 See Randal Bowdish, *Theater-Level Integrated Sensor-to-Shooter Capability and its Operational Implications* (1995) US Joint Military Operations Report <http://handle.dtic.mil/100.2/ADA293332> (accessed 5 April 2012).

27 This as especially true in war zones where insurgency forces had accessibility to and expertise in using small surface-to-air missiles. See Cordesman, above n 22, 30.

28 US OSD Roadmap, above n 8, 2. See also, Gregory J Nardi, *Autonomy, Unmanned Ground Vehicles, and the U.S. Army: Preparing for the Future by Examining the Past* (2009) School of Advanced Military Studies United States Army Command and General Staff College Fort Leavenworth, Kansas 10, <http://handle.dtic.mil/100.2/ADA506181> (accessed 4 April 2010).

29 Despite almost constantly being engaged in one war or another, there is a perception among many western military powers that, since the Vietnam conflict, the public has a low tolerance for domestic troop casualties arising out of foreign conflicts. See Charles Levinson, 'Israeli Robots Remake Battlefield; Nation Forges Ahead in Deploying Unmanned Military Vehicles by Air, Sea and Land' *Wall Street Journal* (New York, NY) 13 January 2010, A10. Although whether this is actually the case has been questioned: see Christopher Gelpi, Peter D Feaver and Jason Riefler, 'Success Matters: Casualty Sensitivity and the War in Iraq' (2006) 3(30) *International Security* 7.

30 Sarah Kreps, 'Debating American Grand Strategy After Major War: American Grand Strategy after Iraq' (2009) 4(53) *Orbis* 629.

support.[31] UVs transfer risk from soldier to robot, permitting commanders to transfer troops to vital human-centric roles.[32]

3 A Love Affair with a Predator

In the preceding section we identified some of the main catalysts that lead to the adoption of UVs in the 'war on terror'. The Predator UAV, which has been used from the outset of this conflict, provides a clear illustration of how the new political and military paradigms that have arisen as part of this war, have fostered the UV revolution.

The Predator UAV is a lightweight turboprop propelled plane just over eight metres in length, first developed in the mid-1990s for the US Central Intelligence Agency (CIA).[33] Each Predator UAV operates as part of a cohesive and integrated weapons system, made up of four UAVs with on-board sensors, a ground control station and a satellite communication suite.[34] All parts of this weapons system can be packed for rapid deployment and transport to remote locations within a very short period of time, with human operators remaining in one location controlling UAVs in another remote location, often on another continent and in a different time zone. Like other UV systems, Predators also offer a highly flexible and customisable equipment platform. Removing the pilot from an aerial vehicle creates about 2.3 metric tonne of extra carrying capacity,[35] freeing up space and weight which can be used to retrofit a wide range of sensors or specialised equipment to suit the task at hand.[36] Alternatively, they can also be fitted with weapons

31 Ali A Jalali, 'Winning in Afghanistan' (2009) 39(1) *Parameters* 5.

32 See Nardi, above n 28, 10.

33 The Predator was developed for the CIA by General Atomics Aeronautical Systems and is based on earlier Israeli UAV systems. See Yenne, above n 10, 56-57. For information on the Predator UAV see US OSD Roadmap, above n 8, 4. See also Bill Gunston, 'Unmanned Aircraft – Defence Applications of the RPV' (1973) 4(188) *Royal United Services Institute for Defense Studies Journal* 41.

34 It is for this reason that predator and similar drone systems are often referred to as Unmanned Aerial Systems or (UAS). See R J Newman, 'The Little Predator That Could' (2002) 3(85) *Air Force Magazine* 48.

35 This is because, not only is the pilot no longer on board, there is no longer the need for a cockpit, ejector seats, atmospheric protections and controls. Indeed removing the pilot also renders much of the armor required to protect a human occupant redundant. See Gunston, above n 33.

36 For instance, Predator drones undertaking ISR duties carry a large range of sensor equipment including high-powered colour and night vision equipped cameras, infra-red and heat sensors. See Newman, above n 34, 51.

systems, the most popular of which is the Hellfire missile, a long-range, supersonic missile designed for 'precision'[37] attacks on heavy armour.[38]

Prior to 2001, the Predator was used sparingly outside of covert operations, in part as a result of latency issues and a lack of integration with mainstream military forces.[39] However, by 2001 communications problems were largely overcome and it became apparent that the CIA was already using a small number of Predator drones to covertly search for Osama Bin Laden in Afghanistan.[40] From October 2001, Predators were flying ISR missions, and in February 2002, the Predator undertook its first operational strike, armed with hellfire missiles.

In the wake of these initial sorties, analysts lauded the Predator as a panacea for the special operating conditions required by the war on terror.[41] What was most exciting for military planners was its ability to pass real-time ISR data to strike teams and decision makers, located both inside and outside of the conflict zone. Predators solve much of the 'sensor-to-shooter cycle' problems in the insurgent focused Afghan and Iraq conflicts by providing live surveillance feeds to combat teams that are able to engage with the target instantly.[42]

In addition to the aforementioned benefits of UVs, the versatility of the predator platform and its transportability have also been credited with its rapid adoption and expansion post 2001. Predators, like other UAVs, are also extremely inexpensive to operate in comparison to conventional manned equivalents.[43] Furthermore, they act as 'force multipliers', allowing soldiers and operatives to have a much wider view of the battlefield than they would have previously had.[44] They also reduce soldiers' workloads, allowing troop

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37 Even though this term is used it is well accepted that, whilst the targeting may be precise the Hellfire's collateral damage may not be. See Roy Braybrook, 'Strike Drones: Persistent, Precise and Plausible' (2009) 4(33) *Armada International* 21.

38 Ibid.

39 Ibid.

40 Ibid.

41 Newman, above n 34, 48; Cordesman, above n 22, 62-63; Stulberg, above n 9, 251.

42 Cordesman, above n 22, 60-61.

43 United States Air Force, *Unmanned Aircraft Systems Flight Plan 2009-2047* (2009) <http://www.fas.org/irp/program/collect/uav.htm> (accessed 1 February 2012) ('US Flight Plan').

44 *Eyes of the Army: U.S. Army Roadmap for UAS 2010-2035* (2010) U.S. Army UAS Center of Excellence, Report no ATZQ-CDI-C, 72 <http://www.fas.org/irp/program/collect/uas-army.pdf> (accessed 20 March 2012) ('US Army Roadmap').

energies to be directed towards critical areas that still require active human involvement.[45]

3.1 An expanding aerial presence – from sideline support to central strategy

Military advances, especially by technology rich superpowers like the US are driven by a consistent belief that scientific and industrial progress will guarantee both military supremacy and success at war.[46] Thus, despite continuing caution by some military strategists, the Bush Administration made funding of high tech UAVs a 'top priority' in its 2003 budget.[47] Government spending on drone programmes has increased ever since, with the Obama Administration spending US$5 billion on drones in the 2012 budget.[48] The result has been a marked increase in the number[49] and type of UVs used on the battlefield by the US, and a revolutionary shift in the focus of modern military operations.

As Stulberg writes, '[i]t is now conventional wisdom that we stand at the dawning of the unmanned aerial vehicle (UAV) revolution in military affairs.'[50] Prior to 2001, the US Department of Defence deployed less than 50 UAVs; by 2006 the number was well over 3,000,[51] and in 2012, the Pentagon now has approximately 7,500 UAVs.[52] The US Air Force trains more UAV

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45 The US Army views UAS' success in its ability to 'significantly augment mission accomplishment by reducing a Soldier's workload and their exposure to direct enemy contact. The UAS serve as unique tools for the commander, which broaden battlefield situational awareness and ability to see, target, and destroy the enemy by providing actionable intelligence to the lowest tactical levels.' See US Army Roadmap, ibid, 1.

46 See Jack Beard, 'Law and War in the Virtual Era' (2009) 103(3) *American Journal of International Law* 409, 412.

47 Newman, above n 34, 58.

48 'Predator Drones and Unmanned Aerial Vehicles (UAVs)', *The New York Times* (online), 5 March 2012, <http://topics.nytimes.com/top/reference/timestopics/subjects/u/unmanned_aerial_vehicles/index.html?scp=1-spot&sq=unmanned%20aerial%20vehicle&st=cse> (accessed 14 March 2012).

49 Alan Brown, 'The Drone Warriors' *Mechanical Engineering Magazine* (online) January 2010 <http://memagazine.asme.org/Articles/2010/January/> (accessed 1 March 2012).

50 Stulberg, above n 9, 251.

51 United States Government Accountability Office, *Unmanned Aircraft Systems: Improved Planning and Acquisition Strategies Can Help Address Operational Challenges* (Testimony Before the Subcommittee on Tactical Air and Land Forces, Committee on Armed Services, House of Representatives, 6 April 2006) 5.

52 Levinson, above n 29; 'Predator Drones and Unmanned Aerial Vehicles (UAVs)', above n 48.

operators than conventional pilots, reflecting the new direction of aerial warfare.[53]

4 *Current Aerial Applications*

Modern UAVs can basically be separated out into three main classes:[54] micro and small; medium altitude; and high altitude, long endurance (HALE).[55]

Micro and small UAVs are typically less than a metre in length, while micro UAVs are measured in centimetres. Launch is usually by hand or by catapult, with the drone flying at low altitudes and limited ranges.[56] They are usually battery powered and therefore very quiet.[57] Small and micro UAVs are most commonly used by ground units to provide short-range, up to the minute ISR data.[58] They are also favoured by intelligence bodies such as the CIA.[59] Whilst this class has been previously restricted to largely ISR roles, the US Air Force

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53 Ibid.

54 S A Kaiser, 'Legal Aspects of Unmanned Aerial Vehicles' (2006) 55(3) *Zeitschrift Fur Luft-Und Weltraum-Recht* 344, 345-346.

55 An informative list can be found at the US Flight Plan website, see above, n 43. A more comprehensive overview can be found at the Goebel Public Domain review of UAVs, see Goebel, above n 11. See also NATO's three class classification system as set out in *Strategic Concept of Employment for Unmanned Aircraft Systems in NATO*, 4 January 2010 <http://www.japcc.org/> (accessed 19 March 2012).

56 Although some of the micro rotary wing vehicles can take off of their own accord, and some micro UVs have been developed which can 'cling' to the sides of building then release themselves into flight. See Alexis Desbiens and Mark Cutkosky, 'Landing and Perching on Vertical Surfaces with Microspines for Small Unmanned Air Vehicles' (2009) 57 *Journal of Intelligent and Robotic Systems* 131.

57 James F Abatti, *Small Power: The Role of Micro and Small UAVs in the Future* (2005) Air Command and Staff College, 184.

58 For instance, the RQ-11 Raven can be stored in a backpack, is launched into the air by hand to allow troops in the field to 'see over the next hill' which could be over 10 kilometres away. See AeroVironment Inc, 'AeroVironment Receives $37.9 Million In Orders For Digital Raven UAS, Digital Retrofit Kits' (Press Release, 23 February 2010); AeroVironment Inc, 'War on Terrorism Boosts Deployment of Mini-UAVs' (Press Release, 08 July 2002). Both press releases are available at <http://www.avinc.com/resources/press_room/> (accessed 15 April 2010).

59 The CIA have reportedly used ultra-quiet micro-drones, 'roughly the size of a pizza platter [that] are capable of monitoring potential targets at close range, for hours or days at a stretch. See Joby Warrick and Peter Finn, 'Amid outrage over civilian deaths in Pakistan, CIA turns to smaller missiles', *Washington Post* (Washington DC) 26 April 2010, A8.

is currently procuring a micro weaponised UAV known as a Switchblade, which 'launches from a small tube that can be carried in a backpack.'[60]

Medium Altitude Long Endurance (MALE) UAVs generally operate at the same altitudes as conventional commercial aircraft.[61] The Predator is a medium altitude UAV, but is now joined by a wide spectrum of flying vehicles.[62] A second generation hunter-killed Predator B, for instance — also known as the 'Reaper' — is capable of reaching altitudes of 15.8 kilometres and can fly up to 36 hours before refuelling.[63] It has also been designed to provide a more combat focused platform (spawning the term 'Unmanned Combat Aerial Vehicle' UCAV), and can now carry laser guided bombs, Hellfire air-to-ground missiles, munitions and soon an air-to-air missile system.[64] The most updated derivative of the Predator is the MQ-1C Gray Eagle (or Sky Warrior) with the capacity to carry four Hellfire missiles.[65]

Two turbo-fan variants of the Predator have also been designed. The Predator B 'Mariner', a maritime version of the Predator that has been adapted to fly even longer ranges for naval surveillance as well as take-off and land from seaborn vessels,[66] as well as a stealth focussed, turbo-prop Predator variant

60 The Switchblade has been developed as part of the US Air Force Lethal Miniature Aerial Munition System (LMAMS) procurement program. See 'US Air Force Awards AeroVironment $4.2m for Switchblade Loitering Munition System', *Unmanned Aerial Vehicles (UAV) News* (online), 16 February 2012 <http://www.unmanned.co.uk/unmanned-vehicles-news/unmanned-aerial-vehicles-uav-news/us-air-force-awards-aerovironment-4-2m-for-switchblade-loitering-munition-system/> (accessed 19 March 2012); Gary Mortimer, 'Lethal Miniature Aerial Munition System (LMAMS) to be deployed soon?' *sUAS News* (online), 1 January 2011 <http://www.suasnews.com/2011/01/3260/lethal-miniature-aerial-munition-system-lmams-to-be-deployed-soon/> (accessed 19 March 2012).

61 Kaiser, above n 54, 345.

62 See US OSD Roadmap, above n 8, 3-13.

63 Which can be undertaken in the air. The Reaper is also able to be fitted with additional fuel tanks, allowing a fully laden drone (including hundreds of kilos of munitions) to stay aloft for up to two days. See Goebel, above n 11.

64 The 4763-kg Reaper is cleared not only for Hellfire but also for the much heavier GBU-12 Paveway II, GBU-38 Jdam and GBU-49 Enhanced Paveway II, based on 227-kg (class) warheads. See Braybrook, above n 37.

65 Alston, above n 4, 13; Unmanned Editor, 'Specifications Data Sheet,' Unmanned: Ground, Aerial, Sea and Space Systems, 1 July 2011 <http://www.unmanned.co.uk/autonomous-unmanned-vehicles/uav-data-specifications-fact-sheets/gray-eagle-uas-unmanned-aerial-vehicle-uav-specifications-data-sheet/> (accessed 13 March 2012).

66 'Ocean-Going Drones' (2006) 12(165) *Aviation Week & Space Technology* 56.

(the Predator C 'Avenger') which can fly at 400 knots true airspeed and is the fastest in the Predator family.[67]

A range of rotary wing vessels in this class are also in development or in active use, for surveillance and targeting with weaponised versions close to being deployed. The MQ-8B Fire Scout, for instance, is an unmanned helicopter system which is able to be launched from ocean going platforms and travels at speeds of 200 kilometres per hour at up to 6,000 metres for up to eight hours without refuelling.[68] It is able to fire a range of missiles and rockets and carries day/night and multispectral sensors with targeting lasers for strikes by larger aerial vehicles.[69]

High Altitude and Long Endurance (HALE) UAVs fly at altitudes over nine kilometres and are designed for wide area, long-term surveillance. Typically they can stay aloft for long periods of time, providing ISR data over an extremely large target area. Given the highly covert nature of the high altitude spy drones they tend to be highly classified and shrouded in mystery.[70] One exception is the Northrop Grumman RQ-4 Global Hawk, which can reach altitudes exceeding 19 kilometres.[71] Operating at this altitude provides the craft with a surveillance range of over 100,000 square kilometres via high-powered sensors, which can see through clouds, darkness and dust.[72] One military strategist described them as being 'like a low Earth orbit satellite that's present all the time.'[73] The additional advantage of operating at high altitude is that the fighter-jet sized UAV is far outside the range of most

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67 It internalises all storage and weapons bays and is designed to avoid visual and radar detection. The Avenger is also favoured by the Navy given its rear turbofan propulsion system is much safer in naval scenarios. See Goebel, above n 11.

68 US Company Northrop Grumman is currently developing the Fire X which will combine elements of both the MQ-8B Fire Scout and the Bell 407 helicopter, and will have a flight capacity of up to 14 hours. See website of Fire X Manufacturer: 'Fire X: Medium Range Vertical Unmanned Aircraft System,' <http://www.as.northropgrumman.com/products/fire-x/index.html> (accessed 18 March 2012).

69 US OSD Roadmap, above n 8, 9.

70 In 2007 for instance, a UAV resembling a sleek stealth bomber — minus the cockpit — was observed in Khandahar, and subsequently referred to as the 'Beast of Kandahar'. In 2009 the US Air force confirmed that the UAV was in fact an 'RQ-170 Sentinel' tactical surveillance platform. No further information has been provided about the UAV. See Goebel, above n 11.

71 The record set by the Global Hawk was 19,928 meters. See, *Records: Experimental and New Technologies World Records*, FAI Record File Num #7352 <http://records.fai.org/uav/aircraft.asp?id=2151> (accessed 18 March 2010).

72 That means that only five Global Hawks are required to provide high altitude ISR for the whole of the Afghan landmass (and of those, only three need to be aloft at one time).

73 Newman, above n 34, 52.

air defence systems, allowing relatively low risk and constant ISR surveillance. This also frees up human operators from the need to constantly monitor for ground-based threats.

4.1 Swarms

As noted above, early UAV systems, operated as part of a cohesive and integrated system, often with a series of unmanned vehicles (in the Predator's case four). These were originally operated separately, but more recent technology allows for the simultaneous deployment of multiple UVs from a single control station. These 'swarms' allow a 'single operator [to] monitor a group of semi-autonomous aerial robotic weapons systems through a wireless network that connects each robot to others and to the operator.'[74] Swarm technologies have been heralded as a 'milestone in UAV flight' as the best Unmanned Aerial System can be assigned to each request.[75] Further, they will allow for improved response time and reduced manning requirements.[76] Future swarms may also include combinations of unmanned air, sea and ground vehicles.

4.2 UCAVs

Whilst UAVs began primarily as surveillance craft, they are increasingly used for combat roles. Whilst originally this involved retrofitting UAVs with weapons systems a large amount of effort is now going into creating combat specific UCAVs.[77] Facilitating this transition are a range of lightweight missile systems currently in development. These lighter payloads will allow for the weight gains to be put towards improving the engines, armour or stealth capabilities of the drones.[78] Since the outset of the war in Afghanistan in 2001, the number of UCAVs in use, as well as the situations in which they have been used, has grown exponentially. UCAVs are set to be the biggest combat system in US military. In October 2011, a US Predator and a French warplane hit two vehicles fleeing Gaddafi's home town of Sirte, forcing the convoy to disperse, after which Gaddafi was caught by rebels.[79]

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74 Alston, above n 4.

75 US Flight Plan, above n 43, 30.

76 '"Swarm" UAV Reconnaissance Demonstrated', *Homeland Security Newswire* (online), 19 August 2011 <http://www.homelandsecuritynewswire.com/swarm-uav-reconnaissance-demonstrated> (accessed on 18 March 2012).

77 Braybrook, above n 37.

78 Lightweight air-to-surface missiles now under development will open the ground-attack role to far greater numbers of drone platforms. This in turn will pave the way for heavier, stealthy, dedicated unmanned combat air vehicles (UCAVs). See Braybrook, ibid.

79 'Predator Drones and Unmanned Aerial Vehicles (UAVs)', above n 48.

In parallel to the US Department of Defense UAV programme in Afghanistan and Iraq, the CIA has been reportedly running covert UCAV operations in Yemen, Pakistan[80] and Somalia[81] as well as ISR missions in Iran[82] and Syria.[83]

The CIA programme in Pakistan has received significant attention due to the allegedly high number of civilian deaths caused by UCAV strikes. According to research conducted by The Bureau of Investigative Journalism (TBIJ) in 2012, there have been 260 UAVs strikes since President Obama took office in 2009, with approximately 128 strikes in 2010 and 76 in 2011.[84] Although there are no official statistics on the number of casualties, TBIJ research states that between 282 to 535 civilians had been "credibly reported" killed in drone attacks, including more than 60 children.[85]

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80 According to the UK based non-government organisation, Reprieve, the CIA drone programme in Pakistan began in 2004 under the Bush administration, and has expanded dramatically under the Obama Administration. See 'Drone Strikes', <http://www.reprieve.org.uk/investigations/drones/> (accessed 15 March 2012); see also, Andrew Orr, 'Unmanned, Unprecedented, and Unresolved: The Status of American Drone Strikes in Pakistan Under International Law' (2011) 44 *Cornell International Law Journal* 730.

81 Job Henning, 'Embracing the Drone,' *The New York Times* (online), 20 February 2012 <http://www.nytimes.com/2012/02/21/opinion/embracing-the-drone.html?_r=1&scp=4&sq=unmanned%20aerial%20vehicle&st=cse> (accessed 14 March 2012); Craig Whitlock, 'U.S. drone base in Ethiopia is operational', *The Washington Post* (online), 28 October 2011 <http://www.washingtonpost.com/world/national-security/us-drone-base-in-ethiopia-is-operational/2011/10/27/gIQAznKwMM_story.html?hpid=z3> (accessed 14 March 2012).

82 According to media reports, Iran claims to have shot down a US RQ-170 Sentinel drone in Iranian airspace. See Saeed Kamall Dehghan, 'Iran to exhibit US and Israeli Spy Drones,' The Guardian (online), 15 December 2011 <http://www.guardian.co.uk/world/2011/dec/15/iran-exhibit-american-spy-drones> (accessed 14 March 2012).

83 Agence France Presse, 'US drones monitor events in Syria: Report', *DefenseNews*, 18 February 2012, <http://www.defensenews.com/article/20120218/DEFREG02/302180003/U-S-Drones-Monitor-Events-Syria-Report> (accessed 14 March 2012).

84 David Pegg, 'Drone Statistics Visualised', *The Bureau of Investigative Journalism* (online), 10 August 2011 <http://www.thebureauinvestigates.com/2011/08/10/resources-and-graphs/> (accessed 14 March 2012).

85 Chris Woods and Christina Lamb, 'Obama terror drones: CIA tactics in Pakistan include targeting rescuers and funerals', *The Bureau of Investigative Journalism* (online), 4 February 2012 <http://www.thebureauinvestigates.com/2012/02/04/obama-terror-drones-cia-tactics-in-pakistan-include-targeting-rescuers-and-funerals/> (accessed 14 March 2012); 'Predator Drones and Unmanned Aerial Vehicles' above n 48.

5 *A Move to the Ground*

Whilst UVs have become the centrepiece of modern air warfare, UGVs have a much more complex operating and navigational environment. That is not to say that UGVs are not in use by the armed forces; in fact, more ground robots (12,000 in total) are used in Afghanistan and Iraq than UAVs (approximately 7,000). However, the majority of these are remotely controlled or 'teleoperated'[86] and not semi-autonomous.[87]

Teleoperated UGVs are used in a wide variety of situations which pose immediate risks to human combatants; in particular ordinance disposal, urban scouting, and doorway breaching.[88] Small UGVs can also be fitted with a variety of cameras and sensors to see through smoke, at night or detect the existence of explosives, chemical, biological or radiological agents.[89] A weaponised teleoperated UGV,[90] the Special Weapons Observation Remote Direct-Action System (SWORDS) was approved for use in Iraq in 2008.[91] SWORDS are nearly silent to operate and can move as fast as a running person, climb stairs and rock piles, move through wire barriers, sand, snow and water and correct themselves if knocked over.[92]

Larger teleoperated vehicles have been designed to rescue and provide first aid to injured troops under fire, 'with minimal intervention by medic or other first responder operators.'[93] Others have been developed for repair and

86 See definition section above. Teleoperated UGVs are controlled much in the same way as a remote control toy car, with a human operating the vehicle a short distance away, either by sight or via on-board cameras.

87 The most common role for teleoperated UGVs in contemporary conflicts is in the neutralisation of improvised explosive devices: US OSD Roadmap, above n 8, 19.

88 Levinson, above n 29.

89 Nardi, above n 28, 40.

90 SWORDS can be fitted with a range of high velocity, sniper, or machine guns or even rocket launchers. See Stew Magnuson, 'Armed Robots Sidelined in Iraqi Fight', *National Defence Magazine* (online) May 2008, <http://www.nationaldefensemagazine.org/archive/2008/May/Pages/Armed2265.aspx?PF=1> (accessed 15 April 2012).

91 Ibid. However, it is unclear whether the unit has been used or not, as some concerns were raised about the UGVs reliability.

92 K Jones, 'Special Weapons Observation Remote Recon Direct Action System (SWORDS)' in *Platform Innovations and System Integration for Unmanned Air, Land and Sea Vehicles* (Paper 36, Meeting Proceedings, AVT-SCI Joint Symposium) 36–1, 36–8.

93 Katie Drummond, 'Pentagon Seeks Robo-EMS to Rescue Wounded Warriors', *Wired* (online) 3 March 2010, <http://www.wired.com/dangerroom/2010/03/pentagon-seeks-robo-ems-to-rescue-wounded-warriors/#more-22983> (accessed 2 April 2012).

reconstruction under fire, such as moving dirt or repairing craters in runways.[94]

Whilst the majority of UGVs are currently teleoperated, there is a concerted effort to field more autonomous vehicles, which do not require constant human oversight and control. Autonomous or semi-autonomous land based navigation is perhaps the most challenging of the environments for UV programmers and engineers due to the plethora of 'nontrivial navigational capabilities' required to effectively operate in ground roles.[95] However, the Israelis have made significant inroads integrating autonomous UGVs into active military practice.[96] The Guardium UGV, for instance, is a small armoured all terrain vehicle equipped with a wide array of cameras and sensors. It can patrol to pre-programmed coordinates without human control and react to unscheduled events.[97] It was deployed on the Israeli border to detect infiltrators after humans undertaking the same roles were attacked and kidnapped in 2006.[98] A weaponised combat version of the Guardium has been trialled and certified by the Israeli army.[99]

South Korea is reportedly using a similar UGV to the Guardium to patrol its border with North Korea.[100] South Korea also operates stationary robotic platforms that can detect, identify and target intruders in a completely autonomous way, if permitted.[101]

In the US, there has been a concerted effort by the government to bring UGV autonomy up to the level of UAVs and indeed provide for more autonomous

94 See D W Gage, 'UGV History 101: A Brief History of Unmanned Ground Vehicle (UGV) Development Efforts' (1995) 13(3) *Unmanned Systems Magazine*, 2.

95 In this respect both Russian and American space exploration programs have provided major advances to artificial intelligence systems. Indeed, the Russians, unable to afford manned moon exploration, instead placed resources into UVs, placing them at forefront of UGV development until quite recently. See Gage, ibid, 6.

96 This can be attributed to the fact that there is an ongoing state of war in that country combined with a low tolerance for casualties amongst the populace.

97 It does so, 'in line with a set of guidelines specifically programmed for the site characteristics and security routines'. See the Manufacturer website for the Guardium, <http://www.g-nius.co.il/unmanned-ground-systems/guardium-ugv.html> (accessed 12 April 2012).

98 Levinson, above n 29.

99 It can carry over 1000 kilos of weapons and munitions. See GENIUS Unmanned Ground Systems (2010) <http://g-nius.co.il/unmanned-ground-systems/avantguard.html> (last accessed 12 April 2012).

100 See Brown, above n 49.

101 Ronald C Arkin, Governing Lethal Behavior: Embedding Ethics in a Hybrid Deliberative/Reactive Robot Architecture (2007) *Georgia Institute of Technology*, 5.

and complex AI in the future.[102] Currently, the US is trialling a number of medium to large UGV systems.[103] These include: the Black-I Robotics unmanned crossover land vehicle, similar in weight and specifications to the Guardium UGV;[104] a larger, truck sized, Multifunction Utility Logistics Equipment (MULE) UGV designed mostly for transport and operations support;[105] and heavier six-ton UGV tank code-named the 'Crusher' for heavy payloads and rugged terrain.[106] The Crusher can operate in semi-autonomous mode, or be remotely teleoperated by satellite link.[107]

6 On and Under Water: Naval UVs

6.1 Surface vehicles

Unmanned surface vehicles (USVs) are arguably the least developed of the UV family, despite the fact that the surface of the water — at least calm water — is perhaps the most easily navigable environment for a robotic AI. Indeed, robotic technology is sufficiently advanced that UV systems can be retrofitted to (up to fifteen per control unit) conventional watercraft to provide them with semi-autonomous functions.[108] There have been recent forays into semi-autonomous UAVs however. The Israeli Protector is a nine metre sealed, rigid hull USV,[109] designed to protect against seaborn terrorist attacks.[110] It

102 National Research Council (US), *Technology Development for Army Unmanned Ground Vehicles* (2002) 1-12.

103 Office of the Secretary of Defense (US), *Unmanned Systems Integrated Roadmap*, (2009) Report no FY2009–2034, 111-134 ('Integrated Roadmap').

104 Although it is also designed to undertake perimeter patrols and surveillance, the US is currently focusing much of their UGV deployment strategy on gear transport for ground units. The Black-I Robotics UGV is designed to carry packs, food, water, and ammunition for light infantry forces, which it will follow automatically through a range of terrains for up to eight-hour shifts before refueling. See Black-I Robotics <http://www.blackirobotics.com> (accessed 14 May 2012).

105 Integrated Roadmap, above n 103, 116.

106 Ibid 118.

107 Ibid.

108 The UAPS20 is an 'Unmanned Autopilot System' designed by an Italian company, SIEL, which can be fitted to a rigid-hulled inflatable boat to turn it into a low cost USV that can undertake relatively complex waypoint navigation as well as teleoperated control. Up to fifteen boats can simultaneously be controlled for a wide range of tasks, from harbor patrol and surveillance, to ordinance countermeasures and even as a UAV or UUV launch platform. See SIEL, <http://www.sielnet.com/index.php/products/usv> (accessed 20 April 2012). The company also cites the possibility of using the system for 'naval targets' but does not provide any further information on how this may work, quite possibly because the most obvious weaponised use of the system would be as a boat-bomb.

109 See RAFAEL, <http://www.rafael.co.il/Marketing/358-1037-en/Marketing.aspx> (accessed 12 March 2010).

operates a water jet engine, allowing it to travel at speeds of 50 knots and can patrol in semi-autonomous mode; although its stabilised machine guns are currently teleoperated by a human controller, as is its public address system.[111] It is now in full service by the Israeli Navy.[112]

While the US has shown some interest in small patrol USVs,[113] it appears to have set its sights on developing much larger USV platforms. In 2010, the US *Defense Advanced Research Projects Agency* (DARPA) launched the Continuous Trail Unmanned Vessel (ACTUV) program.[114] The project seeks to develop a frigate sized USV 'for theatre or global independent deployment' capable of tracking modern diesel electric submarines. DARPA hopes for a highly autonomous vessel 'founded on the assumption that no person steps aboard at any point in its operating cycle.' Communications with base are to be 'intermittent' for the 'global, months long deployments with no underway human maintenance or repair opportunity.'[115] The ACTUV program is still in

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110 Such as the use of an explosive laden motorboat against the USS Cole in 2000. See Erik Sofge 'Robot Boats Hunt High-Tech Pirates on the High-Speed Seas' *Popular Mechanics* (online) 1 October 2009, <http://www.popularmechanics.com/technology/engineering/robots/4229443> (accessed 12 March 2012).

111 S J Corfield and J M Young, 'Unmanned surface vehicles – game changing technology for naval operations' in G N Roberts and Robert Sutton (eds), *Advances in Unmanned Marine Vehicles* (2006) *IEE Control Series*, 313.

112 Which operates it in a semi-autonomous manner to patrol harbors, gather ISR, laying and remove ordinance and engage in electronic warfare. See Matthew Graham, *Unmanned Surface Vehicles: An Operational Commander's Tool for Maritime Security* (2008) Joint Military Operations Department, Naval War College, 10 <http://handle.dtic.mil/100.2/ADA494165> (accessed 20 April 2012).

113 See Sofge, above n 110. The US Navy is currently exploring the capabilities of its Sea Fox USV – "a remote controlled five-meter rigid hull inflatable boat" – to deploy non-lethal weapons including "a directional acoustic hailer, eye dazzling laser and flash-bang munitions." See Unmanned Editor, 'US Navy Equips Unmanned Surface Vehicles with Non-Lethal Weapons,' *Unmanned Surface Vehicles (USV) News* (online), 7 February 2012, <http://www.unmanned.co.uk/unmanned-vehicles-news/unmanned-surface-vehicles-usv-news/us-navy-equips-unmanned-surface-vehicles-with-non-lethal-weapons/> (accessed 19 March 2012); See also US Navy website, <http://www.navy.mil/view_single.asp?id=114818> (accessed 19 March 2012).

114 Defense Advanced Research Projects Agency, *ASW Continuous Trail Unmanned Vessel (ACTUV) Phase 1*, (2010) <https://www.fbo.gov/spg/ODA/DARPA/CMO/DARPA-BAA-10-43/listing.html> (accessed 20 April 2010).

115 Ibid.

progress, with phase two out of a four phase cycle set to commence in July 2012.[116]

6.2 Underwater vehicles

More prominent, both in military and civilian use, are USVs' undersea cousins, UUVs. Ordinance clearing UUVs were deployed by the allies in the early part of the second Iraq war to clear naval mines.[117] As a result a number of navies have fitted destroyer fleets with permanent on-board UUVs.[118]

In 2004, the US Navy mapped a twenty-year 'UUV Master Plan' that would substantially integrate UUVs into all aspects of its operations.[119] The UUV Master Plan envisions UUVs being used for a wide range of undersea operations,[120] to the extent that current manned undersea vehicles may become redundant or extremely limited in future conflicts. These include: ISR collection and distribution; undersea mapping; the creation of moveable naval data and communications networks; countermeasure and decoy operations; and 'time critical strike capabilities against undersea, surface, air and land targets.[121]

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116 DARPA is currently soliciting proposals for phases 2-4 which will involve designing, building and testing the vessel. See Defense Advanced Research Projects Agency, Tactical Technology Office, *Anti Submarine Warfare (ASW) Continuous Trial Unmanned Vessel (ACTUV)* <http://www.darpa.mil/Our_Work/TTO/Programs/Anti-Submarine_Warfare_(ASW)_Continuous_Trail_Unmanned_Vessel_(ACTUV).aspx> (accessed 18 March 2012).

117 During 2003, Australian, British and US UUVs cleared over 2.5 million square meters of the Iraqi coast of mines. Global Security Org, *Intelligence Collection Programs and Systems* (14 May 2008) <http://www.globalsecurity.org/intell/systems/uuv.htm> (accessed 20 April 2010).

118 Including the US and the UK in 2004: see 'Unmanned Remote Minehunting System Installed for USS Momsen Commissioning' *Space Daily* (online) 31 August 2004, <http://www.spacedaily.com/news/uav-04zzo.html>; Nicolas von Kospoth, *Royal Navy Introduces New Reconnaissance UUV* (24 February 2010) Defpro.focus <http://www.defpro.com/daily/details/515/> (accessed 12 April 2012).

119 Department of Navy (US), *The Navy Unmanned Undersea Vehicle (UUV) Master Plan* (9 November 2004) United States Navy Report <http://www.navy.mil/navydata/technology/uuvmp.pdf> (accessed 12 April 2010) ('UUV Master Plan').

120 Based on four pillars 'Force Net, Sea Shield, Sea Strike, and Sea Base'. See Henderson, above n 16, 57.

121 UUV Master Plan, above n 119.

7 *The Drone Gold Rush*

As a result of the demand for UV technology, market commentators have noted that there is a drone gold rush. According to the US Teal Group, the global UAV market is currently worth US$6 billion a year,[122] and will rise to US$12 billion a year by 2018.[123]

Although the global UV market has traditionally been dominated by US[124] and Israeli companies, competitors in Europe[125] and Asia-Pacific are multiplying rapidly.[126] More than forty countries now have UV programs and the competition between these countries for market and technological dominance is increasing.[127] All of the major EU arms companies are now involved in UV production or prototype development.[128] China is reportedly developing its own UAV program, including a copy of the Predator UAV.[129]

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122 iCD research estimates the global value to be at US$7 billion: see Airforce-technology.com, *Snapshot: The Global Market for Unmanned Aerial Vehicles* <http://www.airforce-technology.com/features/feature125724/> (accessed 19 March 2012).

123 Steven Zagola, David Rockwell and Philip Finnegan, *World Unmanned Aerial Vehicle Systems: Market Profile and Forecast, Executive Summary*, 2011 <http://tealgroup.com/index.php?option=com_content&view=frontpage&Itemid=1> (accessed 19 March 2012) ('Teal Group Executive Summary').

124 In 2011, US companies built approximately 1,800 drones out of the 2,600 made worldwide. See Andrew Rettman, 'EU firms Join Gold Rush on Drones', *EU Observer* (online), 17 February 2012, <http://euobserver.com/13/115283> (accessed 19 March 2012).

125 UK and French Defense Departments are currently sponsoring a joint program called *Telemos*, which aims to produce a medium altitude long endurance (MALE) UCAV by 2020. See the Manufacturer website for BAE Systems: <http://www.baesystems.com/cs/groups/public/documents/document/mdaw/mdm3/~edisp/baes_026385.pdf> (accessed 17 March 2012). In response, German and Italian companies are working together to develop equivalent MALE technology: see Unmanned Editor, 'Cassidian, Alenia Join Forces for UAV Projects', *Unmanned Aerial Vehicles News* (online), 20 December 2011 <http://www.unmanned.co.uk/unmanned-vehicles-news/unmanned-aerial-vehicles-uav-news/cassidian-alenia-join-forces-for-uav-projects/> (accessed 19 March 2012).

126 Cameron Stuart, 'Drones, Lives and Liberties,' *The Australian* (Sydney), 1 March 2012, 11.

127 The market leaders in UV technology are the US, Japan and Israel, with France following closely behind. See UVS International, *UAV Categorisation, in Yearbook: UAVs Global Perspective* (2004) 156.

128 Teal Group Executive Summary, above n 123.

129 Noel Sharkey, quoted in Rettman, above n 124.

8 *Beyond the Military – The Transition to Civilian Use*

In this section we consider the civilian uses of UVs, both now and into the future. We noted above that UVs have not been used as extensively for civilian purposes as they have military ones. We also highlighted two exceptions to this general rule, the first being limited agricultural use and the second, undersea operations. Whilst the former represented only a very small component of global industrial usage, UVs played a dominant role in the latter. Indeed, it is said that the 'golden age' of UUV technology occurred more than a decade before the UAV revolution, when the public were provided footage of undersea wrecks like the Titanic through the tethered cameras of robotic submersibles.[130] As groundbreaking and popular as such operations were, they were actually made possible because of a knowledge and resource pool created by virtue of commercial and industrial uses of the technology; for instance, as petrochemical and mineral extraction, or subsea pipeline and cable laying and maintenance.[131] Those industries have a particular interest in developing robotic technologies that could supplant humans in the undertaking of 'dirty, dangerous or dull' jobs in alien, high risk, environments. Above the water however, there was much less of an impetus to the development of expensive alternatives to human operated vehicles and UV development has therefore historically been driven the military sectors of wealthier nations seeking to transfer the risk from human combatants to machine ones.

Recently there has been marked transition from military to civilian uses for drone technologies. This has been driven by a number of factors:

- Inter-agency transfer: As drones have moved beyond being highly expensive prototype hardware to more mainstream military and research vehicles there has been an increasing willingness for inter-agency transfer of drones for civilian use or trials.[132]

- Increasing international demand: As a result the of the increasing market competition for ever an ever wider range of countries unmanning their military sectors, the price of drones has decreased

[130] In fact, the first 'golden age' in UV technology occurred under the oceans more than a decade before it did in the air. See Henderson, above n 16, 57.

[131] Stephanie Showalter, 'The Legal Status of Autonomous Underwater Vehicles' (2004) 38(1) *Marine Technology & Society Journal* 80.

[132] For instance, armies have provided drones to police forces for trials, air forces have similarly provided UVs to search and rescue teams to deal with large-scale emergencies. See R Johnson, *NASA drones aid firefighters* (2008) *Electronic Engineering Times* 1535, 9-10; Randal C Archibold, 'U.S. Adds Drones to Fight Smuggling' *New York Times* (New York) 8 December 2009, A.25; and Graham Warwick, 'Drug Drones' (2009) 170 *Aviation Week & Space Technology* 22.

significantly bringing them within reach of non-military bodies, whom manufactures view as an important new market.[133]

- Public R&D Support: The massive R&D push into drone technology and computing generally has brought both know-how and inexpensive technology into the wider public arena.

- Increased access to powerful hardware platforms: Over the past two decades computing power and hardware systems have become incredibly powerful, inexpensive and, more importantly, widely available to commercial markets.[134] Consumers can now purchase 'off the shelf' systems that are almost, if not as, complex and powerful as those available to the military.[135] Conversely, the military has become increasingly reliant on commercial hardware, consequently much of the technology used in the construction of UVs are available on the open market.[136]

Drone technology is increasingly within the reach of public bodies, private companies and even individuals. This trend will most likely continue. We have already set out some of the roles that UVs are being used for by such bodies, recognising that as the technology becomes more accessible a range of other applications will no doubt come online.

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133 Stafford writes that when 'commercial drones do take off, four groups of businesses would be looking to cash in. Academic researchers … [with] associations with small, specialist companies that build UAVs. Older commercial companies … have long sold drones as toys. A handful of major corporations already have a toe-hold in the market. And military contractors have perfected the secret designs of the world's best-performing drones — those already used by air forces and spy agencies.' See Ned Stafford, 'Spy in the sky' (2007) 7130(445) *Nature* 808.

134 David S Alberts, *The Unintended Consequences of Information Age Technologies: Avoiding the Pitfalls, Seizing the Initiative* (University Press of the Pacific, 2004) 26–28.

135 Indeed, modern military vehicles and platforms often rely on a mix of military grade and commercially available technology. Jay Stowsky, 'Secrets to shield or share? new dilemmas for military R&D policy in the digital age' (2004) 2(3) *Research Policy* 257. As Gormley notes, 'Military breakthroughs are increasingly resulting from commercial, rather than secret military, research'. See Dennis M Gormley, 'Hedging Against the Cruise-Missile Threat' (1998) 40(1) *Survival* 92.

136 As the US Administration admits, 'Technological advances in propulsion that were previously driven by military-sponsored research are now largely driven by commercial interests—fuel cells by the automotive industry, batteries by the computer and cellular industries, and solar cells by the commercial satellite industry. [UVs] are therefore more likely to rely on COTS [commercial off the shelf] or "COTS-derivative" systems.' See US OSD Roadmap, above n 8, 52.

8.1 Border security

Border security and customs roles are particularly well suited to UAVs,[137] which are now used to detect illegal transborder activities, border infringements,[138] drug[139] and people smuggling.[140] More often than not, these agencies utilise craft, such as the Predator drone, which are directly seconded from the military and, as of yet, it is rare to find UVs specifically designed for non-military surveillance.

8.2 Policing

Policing is another sector in which UVs are beginning to appear. The British police have been particularly enthusiastic about UVs and, under the rubric of the UK Government Home Office, have been developing a nationwide drone program since at least 2007.[141] The program reportedly includes trialling

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[137] For instance, Reaper drones are now deployed by the international anti-piracy task force to scout for Somali pirates in the Indian Ocean. The drones are operated from a base in Germany to follow and record movements of suspect pirate vessels. Although many boats have been captured it has been extremely hard to prove that they were involved in piracy. The ability of the drones to capture video of suspect movements, over long periods of time (up to 18 hours) without detection makes them perfect for the detection and evidence-gathering role.
See Will Ross, 'Drones Scour the Sea for Pirates' *BBC News* (online) 10 November 2009 <http://news.bbc.co.uk/2/hi/africa/8352631.stm> (accessed 15 March 2012).

[138] Countries like Australia that have larger border areas are reportedly trialling semi-autonomous patrols of large areas of its northern approaches. See Ari Sharp 'Unmanned aircraft could soon patrol borders' *The Age* (online), 6 April 2010 <http://www.theage.com.au/national/unmanned-aircraft-could-soon-patrol-borders-20100405-rn4l.html> (accessed 1 May 2012).

[139] In late 2009, the US Department of Homeland Security expanded its use of drones into external jurisdictions, including the Caribbean and South America to spot and track drug smugglers. See Archibold, above n 132. The US Navy is also trialling drones over unspecified countries, seeking to use them to detect submersible vehicles that have been used to smuggle drugs into the US. See Warwick, above n 132.

[140] US Predator drones for instance have been used to patrol the Canadian and Mexican borders. See Warwick, above n 132. In Europe, the EU's border agency, Frontex, is reportedly trialling UAV surveillance in Greece, the main entry point for asylum seekers into the EU. Rettman, above n 124.

[141] Paul Lewis, 'CCTV in the sky: police plan to use military-style spy drones', *The Guardian* (online) 23 January 2010, <http://www.guardian.co.uk/uk/2010/jan/23/cctv-sky-police-plan-drones> (accessed 10 April 2012). However, note an earlier talk by the Home Office which was reported by La Franchi. See Peter La Franchi, 'UK Home Office plans national police UAV fleet', *Flight International* (online) 17 July 2007, <http://www.flightglobal.com/articles/2007/07/17/215507/uk-home-office-plans-national-police-uav-fleet.html> (accessed 10 April 2012). Police in Australia are also trialling drones which may be used for detecting drug crops and finding

medium and low altitude UAVs, with an arrest being assisted by the use of a small UAV for the first time in 2010.[142] The program envisions military UAVs being modified for a wide range of civilian law enforcement activities, including 'routine monitoring of antisocial motorists, protesters, agricultural thieves and fly-tippers'[143] as well gathering evidence of 'vandalism, graffiti or littering.'[144] At the 2012 London Olympics, unarmed UAVs will be used for crowd surveillance and security.[145]

In addition to drones, UK police are also using UGVs including the Wheelbarrow Mk9 remote explosive ordinance device, while the UK National Rail and London Fire Brigade are using small UGVs to deal with acetylene rail fires.[146]

According to reports, other police forces have also sought to arm ground and aerial drones with Tasers for non-lethal engagement of suspects.[147] Although

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missing persons. See Kate Kyriacou, 'Queensland Police trial hi-tech surveillance drones to chase criminals', *The Courier Mail* (online), 14 March 2012 <http://www.couriermail.com.au/news/technology/attack-of-the-drones/story-fn7cejkh-1226298835589> (accessed 19 March 2012). Following an incident in which a police helicopter was shot down in Rio di Janerio, police are now using Israeli UAVs to patrol favelas or shantytowns. See 'State of the Art' (Summer 2011) 1(2) *Unmanned Systems: Mission Critical* <http://issuu.com/auvsi/docs/usna_mission_critical_summer/18> (accessed 25 March 2012).

142 Although no conviction was recorded. See, 'Unlicensed police drone grounded', *BBC News* (online), 16 February 2010, <http://www.clickliverpool.com/news/national-news/128901-merseyside-police-drone-fails-to-convict-car-thief.html> (accessed 10 April 2012).

143 Ibid.

144 David Hambling, 'Future Police: Meet the UK's Armed Robot Drones' *Wired News* (online) 10 February 2010 <http://www.wired.co.uk/news/archive/2010-02/10/future-police-meet-the-uk%27s-armed-robot-drones> (accessed 25 May 2012).

145 See Lewis, above n 141; Stephen Graham, 'Olympics 2012 Security: Welcome to Lockdown London' *The Guardian* (online) 12 March 2012, <http://www.guardian.co.uk/sport/2012/mar/12/london-olympics-security-lockdown-london?INTCMP=SRCH> (accessed 14 March 2012).

146 Yvonne Headington, 'UGVs Ok with UK Police; UAVs up in the Air,' (Summer 2011) 1(2) *Unmanned Systems: Mission Critical*, 9 – 11, <http://issuu.com/auvsi/docs/usna_mission_critical_summer/11> (accessed 25 March 2012).

147 See Lewis, above n 141. However, the authors' could find no official verification of this. The Sheriff's Office of Montgomery County, Texas has reportedly been operating a Shadowhawk drone with the capacity to fire a Taser gun since November 2011. It is unclear however, whether the drone has been used in an armed capacity. See 'Tase of Our Lives', *The Daily* (online), 12 March 2012

the use of Taser drones could not be verified by the authors, two French companies market small and micro UAVs which can variously be armed with a 44mm flash-ball-gun,[148] tear-gas canisters,[149] or Tasers.[150]

8.3 Patrolling and inspection

The need to patrol large restricted areas is not limited to the military. Various industries require ground and air surveillance. For instance, semi-autonomous UGVs have been suggested for a range of industries including: nuclear and electric power plants; railway lines and tracks; sensitive industrial and research areas; oil and gas pipelines, refineries and storage areas; zoos, wildlife reserves and safaris and even private farms and ranches.[151] Semi-autonomous patrol vehicles are obviously well suited to monitoring gaols and detention centres, many of which are now privately operated.[152] Dull and routine operations, such as car parking inspection, have also been highlighted as a possible role for semi-autonomous UGVs.[153] Similarly, the need to inspect cars and vehicles for bombs or other hazards is not limited to the military; security firms protecting hotels, conference centres and other organisations at risk of terrorist activities are very interested in robots that can undertake these dangerous tasks.[154]

8.4 Emergency and hazard management

Adapted military drones have also proven successful in emergency management fire fighting, where they can be used for monitoring operations in dangerous environments.[155] For instance, predator drones with specially

<http://www.thedaily.com/page/2012/03/12/031212-news-armed-drones-1-2/> (accessed 14 March 2012).

148 'Eurosatory 2004 - Tecknisolar Seni designs armed mini-UAV for anti-terror operations', *Flight International* (online), 22 June 2004, <http://www.flightglobal.com/articles/2004/06/22/183201/eurosatory-2004-tecknisolar-seni-designs-armed-mini-uav-for-anti-terror-operations.html> (accessed 25 May 2010).

149 Ibid.

150 See iDrone Website, <http://www.idrone.fr/ (accessed 20 March 2012).

151 See Israel Aerospace Industries Ltd website: <http://www.iai.co.il/34056-31663-en/Groups_Military_Aircraft_Lahav_Products_UGV.aspx> (18 April 2012).

152 Douglas McDonald, 'Public Imprisonment by Private Means - The Re-Emergence of Private Prisons and Jails in the United States, the United Kingdom, and Australia' (1994) 34 *British Journal of Criminology* 29, 29.

153 Richard Bloss, 'By air, land and sea, the unmanned vehicles are coming' (2007) 34(1) *The Industrial Robot* 12, 14.

154 Ibid.

155 Fire fighters can be blinded by smoke and debris during firefighting operations and wander into areas that are dangerous. For instance, certain regions of the fire

designed heat sensors were provided to Californian authorities to help them battle against the massive wildfires that ravaged that state in 2008.[156] In that case only fire surveillance was provided, but in the future, custom-built fire fighting and water bombing UAVs may be used to combat fires, removing human pilots from the high-risk environment of wildfires. In a more recent example, Global Hawk UAVs were used following the tsunami and earthquake in Japan in March 2011 to provide 'real time data to disaster relief.'[157]

UVs also promise to provide ground support in areas inaccessible to rescue crews. Small teleoperated and semi-autonomous UGVs designed for reconnaissance in houses and caves are well adapted to exploring earthquake, disaster zones and other hazardous terrain for survivors.[158] Both the Japanese fire service[159] and the Israeli military[160] have been have been trialling rescue UVs that can rescue injured persons in high-risk areas. Not only would these be important in troop rescue, but they also could be used to extract civilians from remote regions, disaster zones, fires or even riots.

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may be too hot for humans, or areas of the ground may be covered in ash that would cause the firefighters' boots to melt.

156 Heat detecting and radar equipment were retrofitted to the drones so that they could 'see through' the smoke layer to provide fire fighters with up-to-the-minute intelligence on the fire as well as any obstructions, hazards or impediments not visible to human eyes on the ground. See Johnson, above n 132, 9-10. Despite resistance in Europe, small UAVs are also being used to monitor fire 'hot spots' by fire services in Hungary and Spain. Lindsay Voss, 'Unmanned Systems vs. Wildfires' (Summer 2011) 1(2) *Unmanned Systems: Mission Critical* 30, 32-33 <http://issuu.com/auvsi/docs/usna_mission_critical_summer/33> (accessed 25 March 2012).

157 Saira Syed, 'Drone Markets Target Asia for Growth,' *BBC News* (online), 16 February 2012 <http://www.bbc.co.uk/news/business-17028684> (accessed 15 March 2012).

158 Brian Yamauchi and Pavlo Rudakevych, 'Griffon: A Man-Portable Hybrid UGV/UAV' (2004) 5(31) *Industrial Robot* 443, 443.

159 Brian Ashcraft, 'Just Press "Save": Disaster search-and-rescue in robot-crazy Japan' (2009) *Popular Science* (online) 14 May 2009, <http://www.popsci.com/scitech/article/2007-07/autonomous-flying-ambulances-could-save-troops#> (accessed 2 February 2010).

160 David Axe, 'Autonomous Flying Ambulances Could Save Troops' (2007) *Popular Science* (online) 7 November 2007 <http://www.popsci.com/scitech/article/2007-07/autonomous-flying-ambulances-could-save-troops#> (accessed 2 February 2010).

8.5 Remote exploration works and repair

In the undersea environment, UUVs have been used for decades to undertake repairs to hulls, pipelines, or oil rigs.[161] More autonomous UUVs are being developed which will undertake this work automatically.[162] UUVs are also being used for underwater exploration, including the US Oceans Observation Initiative which aims to conduct a bottom to surface mapping of ocean activities over a period of three decades. The Initiative will operate with two major arrays on the East and West coast of the US, as well as four stations in the Pacific, off the coast of Greenland, Argentina and Chile. UUVs, including the Remus 600 and Slocum gliders will be used to transmit data from approximately 800 instruments to researchers (and civilians) around the world, with the first data expected to be available in 2013.[163]

Repair systems are in development on land, including maintenance of remote drilling stations, mineral exploration in remote areas, as well as plumbing and maintenance robots that travel subterranean sewer pipes monitoring for weakness or structural breaches, automatically repairing the damage, or, where that is not possible, recording and alerting controllers to it.[164]

Israeli companies have produced a range of heavy UGVs for bulldozing and earthmoving, which are in active use, to undertake structural works under fire. Whilst teleoperated, future earthmoving UGVs are likely to be automated to undertake routine maintenance of runways, fire-trails, civil engineering, resource transport, or clearing forest and farmland.[165]

8.6 Urban transport

Whilst UGVs are able to operate off-road and for limited on-road military uses, it is relatively well accepted that they are not yet ready for the nontrivial

161 Carl E Nehme, *Modeling Human Supervisory Control in Heterogeneous Unmanned Vehicle Systems* (PhD thesis, Department of Aeronautics and Astronautics, Massachusetts Institute of Technology, 2009) 28.

162 Ibid.

163 Brett Davis, 'Discovery and Exploration: Ocean Observatories Initiative Takes Shape Under the Oceans' (Winter 2011) 1(4) *Unmanned Systems: Mission Critical* (online) 7-11 <http://issuu.com/auvsi/docs/mission_critical_winter_2011/1> (accessed 25 March 2012).

164 Researchers at the University of California, Irvine are developing drone technology which would repair aging subterranean pipes from the inside using carbon fibre. See Tom Vasich, *No Mere Pipe Dream* University of California - Irvine <http://www.uci.edu/features/2010/02/feature_piperobot_100208.php> (accessed 12 January 2012).

165 Howard Cannon, *Extended Earthmoving with an Autonomous Excavator*, (Master's thesis, Technical Report CMU-RI-TR-99-10, Robotics Institute, Carnegie Mellon University, 1999).

navigation required to operate on public highways and roads.[166] Despite this, there have been concerted efforts to advance technology to a level where it can safely operate in civilian traffic zones. Proponents hope that one day automated vehicles will act as taxis, reduce traffic congestion, combat global warming emissions, and reduce road fatalities.[167]

One of the leaders in the field, Google, has completed over 200,000 miles with its fleet of autonomous Prius vehicles.[168] The Prius uses 'artificial-intelligence software that can sense anything near the car and mimic the decisions made by a human driver.'[169] It can even be programmed for different driving personalities.[170]

Most major automobile companies are also developing autonomous or semi-autonomous vehicles,[171] such as BMW's ConnectedDrive Connect (CDC) system which operates using four types of sensors – radar, camera, laser scanners and ultrasound distance sensors – to detect cars in front and in

166 The nontrivial navigational requirements for civilian motor traffic are simply beyond most of today's artificial intelligence systems. Semi-autonomous UVs must deal with complex road rules, highly congested traffic, varying road and weather conditions and non-automotive traffic such as cyclists and pedestrians. More to the point, they must deal with other vehicles that may not be strictly adhering to the same road rules they will be programmed with along with unexpected events, emergencies or impediments (such as a child or animal straying onto the road).

167 See, for instance, futurist and urban designer Michael Arth's, forthcoming book, 'The Labors of Hercules: Modern Solutions to 12 Herculean Problems' (online) 2009 <http://michaelearth.com/herc_V_eco.html> (accessed 26 May 2010).

168 Luke Vandezande, 'California may be next to legislate autocars', *AutoGuide* (online), 1 March 2012, <http://www.autoguide.com/auto-news/2012/03/california-may-be-next-to-legislate-autonomous-cars.html> (accessed 25 March 2012) ; Tom Vanderbilt, 'Let the Robot Drive: The Autonomous Car of the Future is here', *Wired* (online) 20 January 2012, <http://www.wired.com/magazine/2012/01/ff_autonomouscars/all/1> (accessed 25 March 2012).

169 John Markhoff, 'Google Cars Drive Themselves, In Traffic', *The New York Times* (online), 9 October 2010, <http://www.nytimes.com/2010/10/10/science/10google.html?pagewanted=1&_r=2> (accessed 25 March 2012).

170 Ibid.

171 See for example, the Chevrolet EN-V developed by General Motors, which is a two seat electric urban mobility vehicle. Audi and Volkswagen developed the Autonomous Audi TT which completed a 14,110-foot mountain summit in 2010. Japanese company ZMP is currently selling its autonomous vehicle, Robocar to researchers for US $84,000. See 'State of the Art,' (Spring 2011) 1(1) *Unmanned Systems: Mission Critical* (online) 21, <http://issuu.com/auvsi/docs/missioncritical_spring_final_hi/23> (accessed 25 March 2012).

adjacent lanes.[172] The vehicle was trialled on the German Autobahn in 2011, and is expected to go into production 'in a few years.'[173] Although conservative estimates predict that autonomous cars will be sold commercially by 2020, more enthusiastic proponents hope to have such cars on the road by 2015.[174] Pre-empting this shift in the urban landscape, legislation has been implemented in the US state of Nevada, requiring the adoption of regulations authorising autonomous vehicles.[175]

Both the US and the European Union have been funding autonomous UGV research and development since the 1980s. DARPA has attempted to encourage public sector involvement in UGV autonomy through the DAPRA Grand Challenges, a series of task-based competitions pitting different UGVs against each other, most recently in the urban environment, for a total prize pool of US$3.5 million.[176]

The US Department of Transportation Intelligent Transportation Systems Joint Programme Office is developing vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) technology whereby unmanned cars rely on 'connected and cooperative systems to communicate with the roads and each other.' For

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172 Tara Kelly, 'BMW Self-Driving Car: Carmaker Shows off Hands-free Car on Autobahn,' *The Huffington Post* (online), 26 January 2012 <http://www.huffingtonpost.com/2012/01/26/bmw-self-driving-car_n_1234362.html> (accessed 25 March 2012).

173 Peter Murray, 'A Look at BMW's Semi-autonomous Driving Car', *Singularity Hub* (online), 2 February 2012 <http://singularityhub.com/2012/02/02/a-look-at-bmws-semi-autonomous-driving-car/> (accessed 25 March 2012).

174 Ibid.

175 Peter Murray, 'Driverless Cars Bought Closer to Reality as Nevada Passes Bill', *Singularity Hub* (online), 28 June 2011 <http://singularityhub.com/2011/06/28/driverless-cars-brought-closer-to-reality-as-nevada-passes-bill/> (accessed 25 March 2012). Similar bills have also been introduced in California, Hawaii, Oklahoma, Florida and Arizona. See Amanda Crawford, 'Google's Driverless Cars get Boost as California Mimics Nevada', *Business Week* (online), 1 March 2012, <http://www.businessweek.com/news/2012-03-01/google-driverless-cars-get-boost-in-california> (accessed 25 March 2012).

176 The Challenge aims to develop 'technology that will keep warfighters off the battlefield and out of harm's way. The Urban Challenge features autonomous ground vehicles maneuvering in a mock city environment, executing simulated military supply missions while merging into moving traffic, navigating traffic circles, negotiating busy intersections, and avoiding obstacles.' See DARPA, Urban Challenge Overview, <http://archive.darpa.mil/grandchallenge/overview.asp> (accessed 2 April 2012). However, a civilian car maker has been eying the technology, see Jon Stewart, 'Robot cars race around California' *BBC News* (online) 5 November 2007 <http://news.bbc.co.uk/go/pr/fr/-/2/hi/technology/7078245.stm> (accessed, 25 May 2012).

example, a vehicle could detect another car that has run a red light, and would respond accordingly to avoid a collision. Current V2V technology allows vehicles to avoid up to 80% of dangerous traffic scenarios, however more work is needed to counter concerns about privacy and cyber security.[177] The Department is also seeking external input through its Connected Vehicle Technology Challenge.[178]

The European Commission is currently funding the Safe Road Trains for the Environment (SATRE) project, which commenced in 2009 and aims to develop safe and effective 'road train' technology. The system would allow individual drivers to link up to the rear of a train of vehicles which would be controlled by a lead vehicle. Cars would be outfitted with a navigation system and a transmitter/receiver unit, which would allow them to locate and the nearest train and relax, sleep, or work during their commute. Upon arrival at the destination, the driver could split off from the train and retake control of the vehicle.

8.7 Drone journalism

Although domestic regulations in many countries currently limit the use of UAVs for civilian and commercial purposes,[179] several news agencies are operating micro drones capable of obtaining footage from remote or dangerous areas.[180] As UAVs are more fully integrated into commercial

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177 Jerry Hirsch, 'Cars that Communicate Could Improve Safety', *The Los Angeles Times* (online), 20 February 2012 <http://www.latimes.com/business/money/la-fi-mo-connected-vehicles-20120220,0,3927662.story?track=rss> (accessed 25 March 2012).

178 Stephanie Levy, 'Car talk: the science and politics behind vehicles that talk to each other and the roadways', (Spring 2011) 1(1) *Unmanned Systems: Mission Critical* (online) 28 <http://issuu.com/auvsi/docs/missioncritical_spring_final_hi/25> (accessed 25 March 2012).

179 For example, under existing UK regulations, only UAVs lighter than 20kg can be legally flown and operators must have a permit from the Civil Aviation Authority. See Ryan Gallagher, 'Surveillance drone industry plans PR effort to counter negative image', *The Guardian* (online), 2 February 2012 <http://www.guardian.co.uk/uk/2012/feb/02/surveillance-drone-industy-pr-effort> (accessed 19 March 2012). In the US, Congress passed a Bill in February 2012 which will allow for integration of privately owned drones into commercial airspace by 2015. See Brian Bennett, 'FAA moves toward allowing unmanned drones in U.S. airspace,' *Los Angeles Times* (online), 8 March 2012 <http://articles.latimes.com/2012/mar/08/news/la-pn-faa-drones-us-airspace-20120308> (accessed 19 March 2012).

180 For example, a Hextacopter drone was been used by Australia's Nine Network, in a failed attempt to obtain aerial footage of government detention centres for asylum seekers on Christmas Island. See Paige Taylor and Nicolas Perpitch, 'Sixty Minutes drone crashes off death cliff', *The Australian* (online), 14 May 2011 <http://www.theaustralian.com.au/media/sixty-minutes-drone-crashes-off-death-cliff/story-e6frg996-1226055615740> (accessed 19 March 2012).

airspace, drone journalism – including civilian-journalism and paparazzi-journalism – is set to increase.[181]

8.8 Other areas

The civil use of UAVs could be significant and extensive: private and insurance investigation; event coverage; traffic management and monitoring; fisheries protection; real-time disaster reconnaissance and management; aerial surveillance by Surf Life Saving groups;[182] coverage of large public events; mechanised agriculture; power line surveying; aerial photography; film and cinematography; surveillance of foreign Embassies and Consulates;[183] scientific research; environmental monitoring and so on.

Conclusion

Stulberg, quoted above, noted in 2007 that we at the 'dawning' of a UV revolution. It is now safe to say that the revolution is very much upon us, certainly in the military sector, but increasingly in the civilian one. Even in the two years since the précis to this special edition, upon which this article is based, was written there have been significant advances in UV technology, the way it is used and where it is deployed. As the UK Ministry of Defense reported in 2011:

> [UVs] have already changed, and will continue to change, the way that we conduct warfare. Associated technologies are developing at an unprecedented rate and the relentless nature and speed of these advancements make it hard to assimilate, analyse and fully understand the implications: this makes it difficult to plan clearly and confidently for the future.[184]

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181 The first instance of civilian drone journalism to gain international attention was in 2011, when a freelance journalist used a small drone to take birds eye footage of a violent protest in Warsaw. See Mark Corcoran, *ABC News* (online), 'Drone Journalism Takes Off', 21 February 2012 <http://www.abc.net.au/news/2012-02-21/drone-journalism-takes-off/3840616> (accessed 19 March 2012).

182 Surf LifeSaving Australia is trialling UAVs to monitor beaches for sharks and civilians in trouble. See Cameron Stuart, 'Drones, Lives and Liberties', *The Australian*, 1 March 2012, 11.

183 Unarmed UAVs have been trialled by the US State Department to help protect American Embassies and Consulates in Iraq. See 'Predator Drones and Unmanned Aerial Vehicles (UAVs)', *The New York Times* (online), 5 March 2012 <http://topics.nytimes.com/top/reference/timestopics/subjects/u/unmanned_aerial_vehicles/index.html> (accessed 15 March 2012).

184 UK Ministry of Defence, *The UK Approach to Unmanned Aircraft Systems*, Joint Doctrine Note 2/11 (JDN 2/11), 30 March 2011, Concl-1.

It is impossible to completely predict the true form of these advances, or the impact they will have on society. It is also important not to overestimate their impact or their risks. Modern society has proved remarkably adept at integrating and normalising technological developments, especially once any moral panic relating to their introduction subsides. On the other hand, the negative impacts of some technological advancements have only become clear subsequent to their introduction and integration into society; which makes them much harder to regulate and control. Ensuring that such risks are managed in a balanced manner which permits us to benefit from the advances requires prospective consideration, deliberation and regulation. That can be particularly challenging when such advances are so 'speed[y]' and 'relentless'. However, if we do not at least make an attempt we might find ourselves overrun by the technology before we can translate the discussion into effective action (assuming any action is needed). The remainder of this special edition is therefore dedicated to predicting and evaluating the legal issues arising from this technological revolution whose dawn has already appeared to have passed.

Unmanned Vehicles, Surveillance Saturation and Prisons of the Mind

COMMENT BY BRENDAN GOGARTY

Abstract

In this commentary I expand upon the discussion on privacy that I set out with my colleague in the précis to this edition. In particular I consider what the impact of military technologies, designed to achieve persistent and saturation capacity surveillance over war zones might be on civil space and civil society.

1 *Introduction*

Unmanned Vehicles (UVs) are lauded as 'force multipliers' but so too can they be seen as 'problem magnifiers', particularly for the law. That is, in very large part, because they are specifically designed to overcome traditional anthropocentric limitations, extending the reach and influence of their controllers into areas and arenas that the law previously needn't concern itself. In the précis we argued this was particularly apparent in respect of the increasing use of surveillance drones in the civilian space. The recent success of unmanned vehicles (UVs), particularly aerial UVs (UAVs), is very much the result of their capacity to undertake 'high-powered and constant surveillance over vast tracts of land' in conflict zones.[1] Given the majority of current civilian UV technology — especially those employed by state entities — is merely rebadged military adaptations, we argued that their 'adoption into the civilian world will provide the same surveillance capacities to those controlling them; capacities far beyond those envisioned by the Courts of both those countries that recognise a right to privacy, and those that do not'.[2] In this commentary I wish to examine the socio-legal implications of so-called 'global, persistent, surveillance'[3] by UVs employed by the state, over its own, rather than enemy territory. In particular, I will consider the potential impact on privacy and how the erosion of personal privacy will ultimately impact on other freedoms important to civil democratic societies, such as freedom of expression and freedom of association.

This commentary will start with a basic overview of privacy and surveillance. Following this I will discuss how surveillance may impact on certain important privacy rights and consider how UV technologies threaten to erode

1 Brendan Gogarty and Meredith Hagger, 'The Laws of Man over Vehicles Unmanned: The Legal Response to Robotic Revolution on Sea, Land and Air' (2008) 19(1) *Journal of Law, Information and Science* 73, 130 ('précis').

2 Ibid 130.

3 Ibid 80.

those rights much further. I contend that current law is insufficient to act as a check on the over use or misuse of UV surveillance and argue that some form of regulatory debate is required to address current regulatory shortcomings.

This commentary is not intended to recommend or frame possible regulatory responses to that attrition of civil rights. Rather I argue that, should the requisite public and legal debate not happen soon, then it will not only be relatively futile, but that, ironically, it may impact on people's willingness to participate in democratic and participatory activities in the first place.

2 *Privacy and Surveillance: Definitions*

Before examining the impact of UVs on privacy it is important to discuss what privacy is. Unfortunately this is not a particularly easy task. Indeed, it is almost impossible to write about privacy without noting its definitional, conceptual and legal problems.

2.1 Privacy

Privacy is 'somewhat of an esoteric concept, without precise objectively discernable boundaries'.[4] It covers a wide range and forms of behaviour, can be context dependent and subjectively variable.[5] The term can describe everything from interpersonal infringement of body space, to eavesdropping, computer hacking or surveillance by the state. In the précis we covered a larger range of these sub-categories[6] than I plan to discuss here.

What I intend to focus on is the notion of privacy as a 'right to be left alone',[7] particularly from interference and monitoring by the state and its institutions. Specifically I wish to consider the far-reaching consequences of the temporal and physical extension of state surveillance that UV technology now makes possible. I believe this is the most worrisome immediate problem presented by civilian UV technology, at least in the near future.

2.2 Surveillance

Unlike the more nebulous concept of privacy, surveillance is somewhat more of a defined construct. Surveillance, according to James Rule, entails 'any form of systematic attention to whether rules are obeyed, to who obeys and who does not, and to how those who deviate can be located and sanctioned.'[8] Anthony Giddens described surveillance as the 'the supervision of the

4 Précis, above n 1, 126.

5 Daniel J Solove, 'Conceptualizing Privacy' (2002) 90 *California Law Review* 1087, 1092.

6 Précis, above n 1, 124-132.

7 Samuel Warren and Louis D Brandeis, 'The Right to Privacy' (1890) 4(5) *Harvard Law Review* 193.

8 James Rule, *Private Lives and Public Surveillance* (Allen Lane, 1973) 40.

activities of subject populations', especially in the 'political sphere'.[9] He divides surveillance into direct (prisons/schools/workplaces) and indirect insofar as it relates to the authoritarian 'control of information' and the ordering and deployment of that knowledge.[10] Hence, in this paper the term is taken to mean the observation and recording of individuals' behaviour with the ultimate aim of ensuring rule compliance or metering sanction for rule breach.

2.3 Surveillance and privacy – the interface

Surveillance has seemingly direct and obvious implications for privacy, insofar as it results in the viewing and recording of individuals' behaviour and movement. It is often undertaken without the surveillance subject's consent and sometimes without their knowledge. Equally, once recorded, personal information may be re-used in ways, which the subject has not, or cannot be assumed to, have consented to. This would innately appear to be a fundamental breach of privacy. Yet, that innate sense does not always rationally translate into a clear form of actual harm. That is particularly the case where the surveillance is undertaken openly and in the public domain. Yet, sometimes it can even be hard to explain why covert surveillance causes harm or offense in the private domain, especially where the subject of the surveillance is unaware of it.

Much surveillance, particularly audio-visual surveillance, is undertaken in places where the subject would not or could not have a reasonable expectation of privacy.[11] In places like prisons, schools or workplaces direct surveillance occurs with either direct or implied knowledge or consent to being observed by the data subject. Equally, indirect surveillance of public places often does no more than observe and/or record what is open to the general public to view anyway. In a free and open civil society it is neither practical nor appropriate to limit who may watch another, or the manner by which they may do so.

Even if surveillance is surreptitious and not in a public place there may be, Posner points out, 'no rational basis' for a person to claim they are harmed by it.[12] There is clearly no physical harm done to a person if a photo is taken of them in their home, even if it is without their knowledge or consent. Moreover, Posner argues that if nothing is done with the photograph, and the person never finds out it was taken, then there is little cause to claim there

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9 Anthony Giddens, *The Consequences of Modernity* (Stanford University Press, 1990) 59.

10 Ibid.

11 Inasmuch as that phrase relates to the concealment of information from others. See Richard A Posner, *Economic Analysis of Law* (Aspen Law & Business, 5th ed, 1998) 46.

12 Richard A Posner, 'Privacy, Surveillance, and Law' (2008) 75 *University of Chicago Law Review* 245.

was emotional harm from its creation.[13] Similarly, if a telephone is tapped, but only a computer system, listening for key words relating to criminal activity actually monitors it — assuming no such words are used during the conversation — then one might ask, what the harm is, or indeed if anyone's privacy is *actually* breached.[14] To adopt Posner's reasoning, if you are not an antisocial or dangerous person, then there is 'no rational basis' to claim harm from being surveilled, when all that is being monitored for is dangerous antisocial behaviour.

Proponents of state surveillance often defend that position on the grounds that no harm is done, unless those being observed are doing something wrong to begin with. In other words, 'if you've nothing to hide then you've nothing to fear.' Of course the problem with that position is that it treats all of those being watched as potential rule breakers, whether they are or not. Assuming the surveillance is unidirectional it places the watchers in a position of perpetual oversight and power over those under their gaze, whether those people ostensibly should have had a reason to fear in the first place. Finally, it amplifies the power of the watchers to determine what should be feared. Privacy and surveillance scholars such as Goold therefore argue that, 'we should resist the spread of surveillance not because we have something to hide, but because it is indicative of an expansion of state power'.[15] It is perhaps in this sense — that is, the use and abuse of surveillance information by the state — that a compelling case can be made against unfettered and unconstrained surveillance as an abuse of the right to privacy.

2.4 Surveillance as an extension of state power

Whilst some civil libertarians deride any surveillance as a breach of a fundamental right to be 'left alone',[16] the reality is that there has never really been an absolute right in any society for citizens to keep all information about themselves secret and away from the prying eyes of others.[17] Indeed, the idea

13 Ibid.

14 Indeed, one might argue, there is actually little difference if it was a human rather than computer listening in to that conversation, inasmuch as that human would be better trained to discount innocuous references to, say terrorism, and allow the remainder of the conversation to go unrecorded.

15 Benjamin Goold, 'How Much Surveillance is Too Much? Some Thoughts on Surveillance, Democracy, and the Political Value of Privacy' in D W Schartum (ed) *Overvaaking i en Rettstat (Surveillance in a Constitutional Government)* (Fagbokforlaget, 2010) <http://ssrn.com/abstract=1876069>, 44.

16 For a good overview of the normative status of privacy as a right see, Waldo et al, *Engaging Privacy and Information Technology in a Digital Age* (National Academies Press, 2001) 66-69.

17 Indeed privacy as a legal concept only really arose in the nineteenth century, and then as a standalone 'right' in some countries, but not others. That said, the right has become more doctrinally accepted at an international, and multinational level. Indeed in Britain and most other common law countries, courts have been rather inimical to an enforceable common law right to privacy, even against the state, in

of privacy as a right, particularly a human right, is a relatively recent legal concept and one which is intertwined with the development of surveillance technologies.

One of the major, if not the primary, catalysts for the development of domestic and international privacy law has been as a response to monitoring and recording technologies. The invention of the instamatic camera drove the development of the US tort of privacy.[18] Later developments in privacy law at the international level can similarly be seen to be a reaction to the adoption of increasingly powerful and invasive surveillance technologies during the cold war, when spying on foreigners and one's own citizen's became a central apparatus of state intelligence and defense.[19] More recently, transnational data protection laws have been developed as a consequence of the introduction of international telecommunications networks, the Internet and now portable digital communications.[20]

The exception to this general trend has been open public surveillance, particularly of the audio-visual variety. Public surveillance has not received a great deal of regulatory attention or intervention, despite the rapid and near exponential growth of closed-circuit television (CCTV) — especially by state organs — in public spaces over the last four decades.[21] The preponderance of this public surveillance technology, particularly by state institutions, and the seeming complacency about it amongst a large proportion of the public has worried scholars and civil libertarians concerned about its potential impact on civil rights.[22]

2.5 Surveillance and civil rights

The potential impacts of surveillance on civil rights have been subject to analysis, discussion and debate by scholars, philosophers and lawyers for a significant period. Perhaps the most seminal early work was that Jeremy Bentham in 1787 as part of his *Panopticon Letters*,[23] a treatise on the design of

the absence of legislative protection. That position is different in other jurisdictions which recognise a right to privacy, and in international and multilateral agreements such as the ICCP and ECHR. See Dorothy J Glancy, 'The Invention of the Right to Privacy' (1979) 21(1) *Arizona Law Review* 1.

18 See n 63. See also, Robert E Mensel '"Kodakers Lying in Wait": Amateur Photography and the Right of Privacy in New York, 1885-1915' (1991) 43(1) *American Quarterly* 24.

19 See generally, Deborah Nelson, *Pursuing Privacy in Cold War America* (Columbia University Press, 2002).

20 Michael Kirby, 'The History, Achievement and Future of the 1980 OECD Guidelines on Privacy' (2010) 20(2) *Journal of Law, Information & Science* 1.

21 Caoilfhionn Gallagher, 'CCTV and Human Rights: the Fish and the Bicycle?' (2004) 2(2/3) *Surveillance & Society* 270.

22 Ibid.

23 Jeremy Bentham, *The Panopticon Writings* (Verso, 1995) e-version available from <http://cartome.org/panopticon2.htm>.

an efficient prison system. That system was designed around the (then) nominal idea that prisoners would be placed in cells where they always might be observed by prison officers, but could never actually know if they actually were; the prison cells were permanently lit whilst officers were to be placed in an obscured and darkened guard tower. Bentham argued this system would be effective because,

> the more constantly the persons to be inspected are under the eyes of the persons who should inspect them, the more perfectly will the purpose [of social/behavioural control] … have been attained. Ideal perfection, if that were the object, would require that each person should actually be in that predicament, during every instant of time. This being impossible, the next thing to be wished for is, that, at every instant, seeing reason to believe as much, and not being able to satisfy himself to the contrary, he should *conceive* himself to be so.[24]

In other words, people will generally modify their behaviour to comply with rules when they are being watched by those with the power to sanction or punish rule breaking. However, they are also likely to modify their behaviour if there is a *possibility* of being watched by those authorities. That is, the uncertainty of whether someone is being observed can create the same effect on someone as actually observing him or her.

Bentham's system greatly increases the administrative efficiency of monitoring and controlling subject populations, by reducing the locus of that control from a one-to-one ratio to a one-to-many ratio. It achieves this power differential by placing a larger cohort on notice that they *may* be being observed by one or more watchers at any one time, whilst simultaneously denying them the capacity to confirm they *actually* are.[25] Foucault, who built his work upon Bentham's — and who is equally a standard reference in most surveillance literature — described the uncertainty control principle of surveillance as a 'diagram of a mechanism of power reduced to its ideal form… it is in fact a figure of political technology that may and must be detached from any specific use'.[26]

3 Towards a 'Surveillance Society'

Bentham's ideas were both lauded and criticised, but gained little practical traction in practice, either in respect of prison populations or social and population control more generally. That was until the advent of modern audio-visual recording technology which allowed for the installation of recording devices to allow for efficient monitoring of both public and private

24 Ibid.

25 Indeed it is possible that, sometimes at least, no one may actually be watching at any one time; but as long as the subject population does not know that, the effect should be the same.

26 Michel Foucault, *Discipline and Punish: The Birth of the Prison* (Patheon, 1977) 205.

spaces. CCTV cameras in particular have resulted in vast areas of public and private space being monitored and surveilled by a range of entities, but particularly state ones.[27] Added to this is the fact that much human interaction now occurs via technological means and conduits, from telephones to the internet, all of which may be monitored and surveilled, with or without the participants' knowledge. This turned many western countries into what some scholars describe as a 'surveillance society' given that so much of people's lives in these countries is actively monitored, or at least capable of being monitored.[28]

Given the rise of the so-called surveillance society, it might be expected that the early theories of Bentham and others would finally be proven or disproven. Ultimately however, there is a lack of solid evidence that panoptic surveillance is an effective or ineffective mechanism to ensure social control.[29] On the one hand, studies of small groups show that the panoptic effect of uncertainty does result in self-regulation in controlled situations.[30] Panoptic designs have also been integrated into workplaces, and some studies indicate they are successful in increasing productivity, safety and efficiency, especially where the work is in a controlled environment or centres upon electronic communications (for instance, call centres).[31] Other studies are less conclusive or argue that the negative affects of the constant monitoring undermine rather than promote worker morale and satisfaction and thereby reduce efficiency.[32] Outside of controlled studies of small groups the evidence is even more controversial. For instance, some statistics seem to indicate that the introduction of CCTV cameras may reduce crime and anti-social behaviour,

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27 Gallagher, above n 21, 23.

28 David Lyon, *The Electronic Eye: The Rise of Surveillance Society* (University of Minnesota Press, 1994) 57-80.

29 As Vorvoreanu and Baton note, 'The paradox of electronic surveillance is that it is much used and little understood.' Mihaela Vorvoreanu and Carl H Botan, 'Examining Electronic Surveillance in the Workplace: A Review of Theoretical Perspectives and Research Findings' (paper presented at Conference of the International Communication Association, Acapulco, June 2000) 3.

30 For instance, students will avoid prohibited websites when they know their Internet browsing history may be reviewed. S Dawson, 'The impact of institutional surveillance technologies on student behavior" (2006) 4(1/2) *Surveillance and Society* 69; see also Stuart Moran, Isaac Wiafe and Keiichi Nakata, 'Ubiquitous Monitoring and User Perceptions as a Persuasive Strategy' (2011) 3 *Web Intelligence and Intelligent Agent Technology* 41, doi: 10.1109/WI-IAT.2011.112.

31 Shoshana Zuboff, *In the Age of the Smart Machine* (Basic Books, 1988) 322; Jengchung Chen and William Ross, 'Individual differences and electronic monitoring at work' (2007) 10(4) *Information, Communication & Society* 488 doi: 10.1080/13691180701560002.

32 John R Aiello and Carol M Svec, 'Computer Monitoring of Work Performance: Extending the Social Facilitation Framework to Electronic Presence' (1993) 23(7) *Journal of Applied Social Psychology* 537, doi: 10.1111/j.1559-1816.1993.tb01102.x; Marylène Gagné and Devasheesh Bhave, 'Autonomy in the Workplace' (2011) 1(2) *Human Autonomy in Cross-Cultural Context* 163, doi: 10.1007/978-90-481-9667-8_8.

whilst other statistics seem to indicate the opposite, or merely show that the locus, nature and form of the activity shifts without reducing its quantum *per se*.[33] Indeed, some of the critics who argue that CCTV limits fundamental freedoms simultaneously cite its lack of impact on crime as a reason for its abolition.

Perhaps the most that can be said is that, ultimately, it is impossible to truly measure the impact of open surveillance on the population as a whole. Nevertheless, there is evidence that at least some people will be concerned about the monitoring, and, on a small scale at least, will self-regulate. Whilst those involved in crime might find ways around the surveillance,[34] or become nonchalant about it, those who are not involved in or intending to commit crime are still affected by it. In other words, surveillance treats all citizens as potential criminals and puts all on notice they are being watched for possible non-compliance with state authority.

One of the main attacks on unfettered state surveillance is that it may have a panoptic affect on those who challenge or dissent against state authority, but probably more importantly those who might wish to hear, interact or agree with them.[35] Governments have an interest in self-preservation, particularly from those who might undermine their authority, even in civil, democratic societies. Democracy however, can only flourish in an environment in which people are free to say and think what they wish, without fear of retribution or sanction for disagreeing with state policy or practice.[36] Democracy can also only flourish where people are free and unafraid to listen to such ideas and judge the veracity of them for themselves. As Emerson writes, '[a]n individual is capable of [democratic participation] only if he can at some points separate himself from the pressure and conformities of collective life.'[37] If there is nowhere for citizens to have such interactions without being fearful of the

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33 A good meta-analysis of the competing statistics is provided by Brandon Welsh, and David Farrington, 'Public Area CCTV and Crime Prevention: An Updated Systematic Review and Meta-Analysis' (2009) 26(4) *Justice Quarterly* 716 doi: 10.1080/07418820802506206; see also William Webster, 'CCTV policy in the UK: reconsidering the evidence base' (2007) 6(1) *Surveillance & Society* 10; Sam Waples, Martin Gill and Peter Fisher, 'Does CCTV displace crime?' (2009) 9 *Criminology and Criminal Justice* 207, doi: 10.1177/1748895809102554.

34 Simon argues about open surveillance, 'the post 9/11 security situation is that the individuals one hopes to detect are the very individuals that have the best chance of evading detection.' Bart Simon, 'The Return of Panopticism: Supervision, Subjection and the New Surveillance' (2005) 3(1) *Surveillance & Society* 9.

35 Such views are not new, US Justice Felix Frankfurter stated in *Wolf v Colorado*, 338 U.S. 25 (1949) that, the 'security of one's privacy against intrusion by the …[state]– is basic to a free society'.

36 As Keith Boone puts it, privacy is 'vital to a democratic society [because] it underwrites the freedom to vote, to hold political discussions, and to associate freely away from the glare of the public eye and without fear of reprisal.' See C K Boone, 'Privacy and Community' (1983) 9(1) *Social Theory and Practice* 8.

37 Thomas I Emerson, *The System of Freedom of Expression* (Random House, 1970) 546.

gaze of the state, then there is likely to be an impact on the exchange of political ideas. Hence, surveillance scholars like Goold argue that:

> one of the greatest dangers of unfettered mass surveillance is the potential chilling effect on political discourse, and on the ability of groups to express their views through protest and other forms of peaceful civil action … [making it] harder for dissent to flourish or for democracy to remain healthy and robust …[and] the individual is always at the mercy of the state, forced to explain why the government should not know something rather than being in the position to demand why questions are being asked in the first place.[38]

Solove goes further and argues that,

> Surveillance is a different kind of privacy problem than disclosure, imposing a different type of injury to a different set of practices. Surveillance differs from disclosure because it can impinge upon practices without revealing any secrets. Being watched can destroy a person's peace of mind, increase her self consciousness and uneasiness to a debilitating degree, and can inhibit her daily activities.[39]

One must, of course, be cautious about overstating the impact of surveillance on political discourse, just as one must be cautious about overstating its impact on crime. Nevertheless, there is at least some evidence to suggest the panopticon effect operates to deter people from engaging in behaviour that might result in sanction. As major or minor as that impact might be, it is an impact all the same; an impact which will mean that we cannot ever describe our speech or association as completely free. The question is just how much of an impact we are willing to accept, and, once the boundary line is drawn, how we will limit further incursions and encroachment.

UV technology may just be the tipping point beyond which we can safely say there will be a real 'chilling effect' on political discourse, insofar as such technology promises to greatly increase the surveillance capacity of state organs. Surveillance capacity, according to James Rule is determined by examining the:

1. size and scope of files in relation to the subjected population;
2. centralization of those files;
3. speed of information flow; and
4. number of points of contact between the system and its subject population.[40]

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38 Goold, above n 15, 43.

39 Solove, above n 5, 1130.

40 Rule, above n 8, 38.

As was discussed in the précis to this edition, UV technology dramatically increases the 'degree and scale' of all of these things:

> [The] concern about drones is how they may facilitate increasingly broad ranging, invasive and covert monitoring by the state, and possibly private companies and individuals … Unlike current surveillance systems, which tend to involve fixed, visible camera systems in public spaces, UVs will provide highly mobile and generally undetectable surveillance of any area within the relevant jurisdiction. Current UV applications could easily permit a person to be watched as they travel from home to work without their knowledge. Without some constraint, it is possible that covert surveillance will be ubiquitous in the not too distant future.[41]

UVs, particularly UAVs, permit an almost infinite number of points of contact with the population, because of the large and unmarked zones which they may surveil. Indeed, the fact that they are designed to operate without detection and from roving locations increases their panoptic effect, because, unlike modern CCTV cameras, a person can never know if a camera is actually watching them. Furthermore, much contemporary UV technology has been developed for intelligence, surveillance and reconnaissance (ISR) missions in war zones, specifically to collect vast amounts of audio-visual data over massive geographic areas. This generates massive amounts of ISR data that requires complex hardware and software systems to process and refine.[42] ISR data can be stored on conventional data systems at a later stage to review suspect sites and persons at a later date.[43] It is stored in highly centralised and interconnected within state data servers. When considered against Rule's criterion, this is a level of surveillance capacity nearly reaching saturation point.

3.1 Towards surveillance saturation

Although states are currently capable of employing UVs in a manner through which they might potentially achieve surveillance saturation, that is not yet, entirely a reality; but in the absence of immediate law and debate, it is a fast approaching possibility. Already we are seeing a push by state agencies to adopt UV technology as an efficient and convenient solution to civilian policing and security.[44] Indeed, the civilian transition of the technology is almost as rapid and exponential as its uptake in the military sphere post 9/11.

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41 Précis, above n 1, 126.

42 Eli Lake, 'Drone footage overwhelms analysts', *The Washington Times* (online), 9 November 2010 < http://www.washingtontimes.com/news/2010/nov/9/drone-footage-overwhelming-analysts >.

43 In fact the ISR data collected by military UVs is so vast that it is practically impossible for human controllers to process it all. As noted in the précis, it is so wide ranging that nearly every part of Afghanistan may be under observation at any one time. Précis, above n 1, 137.

44 Ibid 106-108.

If that is the case, then UV technology will quickly become as ubiquitous — albeit in a less obvious or transparent way — as that earlier surveillance technology, such as CCTV. That means, without proper debate, we may very well experience the same privacy creep in the use of UV technology that we saw previously with CCTV.

The real effect of the move towards persistent, saturation level surveillance of civilian areas is, of course, also speculative. Nevertheless, there is good cause to assume it will have some affect on people's feeling of freedom to associate and participate in democratic forms of activities which may be unfavourable to, or sanctioned by, the government of the day. For instance police have increasingly turned to videoing protesters with handheld cameras, even at peaceful demonstrations.[45] The response by protesters has been to obscure their faces to avoid identification; and therefore they can, absent of being arrested, assume their privacy is maintained after they quit the protest. The difference in a world of UV surveillance is that those protesters cannot expect to return to anonymity once they leave the protest march and return to their homes and lives. Instead there is a very real chance they may be singled out and followed, silently and unknowingly from the scene of the protest all the way to their home. This is not a dystopian prediction, but rather a very real-world scenario exemplified by the killing of Tariq Azizm in Pakistan in late 2011, which is discussed in the commentary by Hagger and McCormack in this edition.[46]

3.2 Tariq's legacy

Tariq Azizm was killed after attending a meeting, called a 'Waziristan Grand Jirga' — best explained as a hybrid parliament/courtroom — in Islamabad, Pakistan.[47] He had been invited to attend that meeting, along a large group of villages from rural Pakistan, to commemorate drone strike victims and discuss the ongoing impact of such strikes on their own lives with western journalists.[48] Pakistan prevents journalists from entering tribal areas to interview or document drone strikes themselves.

At the Grand Jirga village elders refuted US Government claims that drone strikes were targeted, discrete and did not result in civilian casualties. Because

45 Goold, above n 15, 39.

46 Meredith Hagger and Tim McCormack, 'Regulating the Use of Unmanned Combat Vehicles: Are General Principles of International Humanitarian Law Sufficient?' (2011) 20(2) *Journal of Law, Information & Science* EAP 23, 10.5778/JLIS.2011.21.McCormack.1.

47 Clive S Smith, 'For Our Allies, Death From Above', *The New York Times* (online) 3 November 2011 <http://www.nytimes.com/2011/11/04/opinion/in-pakistan-drones-kill-our-innocent-allies.html>.

48 Justin Randle, 'US Steps Outside the Law as the War on Terror Drones On', *Sydney Morning Herald* (online) 24 January 2012, <http://www.smh.com.au/opinion/politics/us-steps-outside-the-law-as-the-war-on-terror-drones-on-20120123-1qdsu.html>.

of the media blackout in that region, those claims could not be substantiated in a manner sufficient for journalists to publish them to the rest of the world.[49] Consequently, western journalists and charity workers present promised to provide training, equipment and support to volunteer villagers, to permit them to collect 'physical proof that civilians had been killed'.[50] According to reporters present at the meeting, only three people were actually willing to volunteer for such a role, given the serious risks such work entailed; Tariq Aziz was one of those volunteers.[51]

Approximately 72 hours after the meeting in Islamabad, Tariq and his 12-year-old cousin were killed as they drove their car to collect an aunt from a wedding in the rural city of Miran Shah in North Waziristan. It is alleged that two Hellfire missiles (ironically fired from a drone) struck the car, killing both occupants within a few hundred metres of their house.[52] The CIA, which is responsible for such operations, neither confirms nor denies such strikes, so the basis for such claims cannot be substantiated; nor can speculation about if, or how, Tariq was tracked from the Grand Jirga in the capital back to his home town in the provinces. One British human rights lawyer who attended the Grand Jirga claimed, 'a homing device may have been placed in Tariq's car, possibly as a "warning" to others not to raise objections to the drone killings.'[53] As Hagger and McCormack state, 'the accuracy of these reports is almost impossible to determine, as are the reasons why these boys were targeted; herein lies the source of controversy.'[54]

Regardless of whether the claims that Tariq Aziz was killed because of his participation at the Jirga are true, they have been accepted by much of the world's press, and, importantly, many of his tribespeople and countrymen. According to the journalists present at the Jirga, participants had already felt apprehensive about being identified as participants.[55] Indeed, the small number of volunteers to document drone strikes must also be taken as indicative of the fear those participants felt about the proposed data gathering

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49 Pratap Chatterjee, 'Bureau reporter meets 16-year-old three days before US drone kills him', *The Bureau of Investigative Journalism* (online), 4 November 2011, <http://www.thebureauinvestigates.com/2011/11/04/bureau-reporter-meets-16-year-old-just-three-days-before-he-is-killed-by-a-us-drone/>.

50 Smith, above n 47.

51 Ibid. Tariq was said to be one of the few people with computer skills and was also excited about the possibility of being provided with, and trained to use, a digital camera. Pratap Chatterjee, 'The CIA's unaccountable drone war claims another casualty', *The Guardian* (online), 7 November 2011 <http://www.guardian.co.uk/commentisfree/cifamerica/2011/nov/07/cia-unaccountable-drone-war>.

52 Smith, above n 47.

53 Anon, 'Boys' killing belies US claim on drone strikes', *The Australian* (online), 7 November 2011 <http://www.theaustralian.com.au/news/world/boys-killing-belies-us-claim-on-drone-strikes/story-e6frg6so-1226187021609>.

54 Hagger and McCormack, above n 46, EAP 23.

55 Smith, above n 47.

activities. Yet those were entirely peaceful measures, designed to create awareness about, and transparency around, local and foreign government activities and claims. That would seem to be a contradiction of the values of democracy, popular involvement and accountability that western countries such as the US ostensibly stand for. Regardless of whether all the details of Tariq's story are true — indeed, perhaps the uncertainty and speculation about its veracity makes it all the more effective — it sends a compelling message of warning to those who might consider participating in such accountability activities in the future.

Whilst one might hope the consequences in the civilian sphere would be much less dire, Tariq's story indicates the potential consequences of a panoptic society in which there is near, if not complete surveillance saturation. Given the covert nature of much UV technology, a person living in a place where they are regularly employed as surveillance devices can never be sure when or where or why they are being watched. It is hard to imagine how such a situation would not create some reluctance amongst at least part of the population to participate in activities, or interact with people, that are unfavourable to the government of the day.

3.3 Finding a balance

As Goold argues 'we need [privacy] in order to live rich, fulfilling lives, lives where we can simultaneously play the role of friend, colleague, parent and citizen without having the boundaries between these different and often conflicting identities breached without our consent.'[56] Permitting states to increase their surveillance capacity to near saturation point threatens citizens' autonomy to balance and control such boundaries. That, of course, does not axiomatically mean we must prohibit states from employing such technology. Indeed, the horse has already bolted, so to speak, on restraining governments from undertaking mass surveillance. Moreover, there are real and genuine security, economic, social and public interest reasons for utilising public surveillance systems. UV technology will, no doubt, add to those benefits, by, for instance, making sure criminals cannot escape the law by undertaking criminal activity just outside of the sphere of an obviously placed CCTV camera.

Hence, we should not assume that it is only governments that will be attracted to the increased surveillance capacities provided by UV systems. The expansion in state surveillance capacity has not been received as critically or with as much widespread resistance as some may have originally predicted, so it cannot be expected that the additional reach provided by UVs will create a sudden public outcry. As McBride observes 'some people may welcome the introduction of additional technology that may catch or decrease criminal activity', whilst 'others are significantly more apprehensive about the

56 Benjamin Goold, 'Surveillance and the Political Value of Privacy' (2009) 1(4) *Amsterdam Law Forum* 4, <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1509393>.

widespread use of such technology'.[57] Ultimately we may need to find a balancing line between these competing interests.

4 *The Limits of the Law*

Justice Posner observes extra-judicially that:

> People hide from government, and government hides from the people, and people and government have both good and bad reasons for hiding from the other. Complete transparency paralyzes planning and action; complete opacity endangers both liberty and security.[58]

Ultimately the role of the law is to both regulate and provide a socially acceptable balance between these two important competing interests. Yet, as was argued in the précis paper, the common law at the very least is relatively ill equipped to deal with modern surveillance systems and the socio-political issues they present.[59] Without reiterating the entirety of that argument, the main reasons for this are:

- Many common law countries still do not recognise a tort of privacy.

  In countries without a tort of privacy, laws that traditionally protect privacy, such as nuisance, trespass or confidentiality have extremely limited applicability to any form of surveillance of a public space and little in the way of 'actionable rights against UVs that are used to survey their private property'.[60]

- In those countries (notably the US) that do recognise a tort of privacy — and to an extent where confidentiality is relied upon — it is based upon what a person might 'reasonably expect' to be safe from prying eyes. As technology becomes more accessible and ubiquitous, no person can reasonably expect not to be surveilled from one vantage point or another.

In his commentary, Jim Davis argues that some of these concerns are overstated, insofar as:

> the reasonable expectation of privacy arises not from the fact that the subject of the intrusion had no reason to suspect that he or she was being covertly watched, but from the fact that the conduct of the subject of the

57 P McBride, 'Beyond Orwell: The Application of Unmanned Aircraft Systems in Domestic Surveillance Operations' (2009) *Journal of Air Law and Commerce* 74, 629, 638.

58 Posner, above n 12, 246.

59 Précis, above n 1, 126-130.

60 Ibid 127.

> intrusion is such that a reasonable person would be highly offended if that conduct were published to the world at large.[61]

Davis therefore contends that 'that such an expectation of privacy is [not] becoming harder to maintain' even in the face of technological advances which increase the scope and degree of surveillance capacity by both private and state actors.[62] Davis' legal analysis in this respect is, of course, correct. However, courts have looked to a variety of factors to determine when someone may have a 'reasonable expectation' of privacy, or be 'highly offended' when their privacy is breached. In some instances the technological ubiquity of the device or measure utilised to surveil a person is relevant to establishing those objective standards, in other cases it is not. Furthermore, I would also argue that there is a very fine, if not largely artificial, line between having 'no reason to suspect' one is being watched and whether 'a reasonable person would be highly offended' at the watching and/or subsequent publication of data collected during it; particularly insofar as that distinction is used as a basis to contend that social expectations of privacy do not change as technology advances.

The highly offensive test is an objective one, ascertained by virtue of what a reasonable person might expect to keep private in the social and temporal conditions in which they find themselves. Such expectations *must naturally change* as society does and technology is a predominant motivator of anthropomorphic and structural change in society. Our movements, communications and interactions may be captured and recorded in ways that were simply unimaginable even a few decades before, let alone the centuries ago when much of our common law developed.[63] Two centuries ago a person

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61 Jim Davis 'The (Common) Laws of Man Over (Civilian) Vehicles Unmanned' (2011) 21(2) *Journal of Law, Information & Science,* EAP 6, 10.5778/JLIS.2011.21.Davis.1.

62 Ibid.

63 It is important to remember that Warren and Brandeis' seminal article 'The Right to Privacy' which led to the adoption of a tort of privacy in the US, was largely written as a response to the invention of the instamatic camera two years before. The result of that invention by Kodak was no small degree of moral panic and outrage and the prohibition of cameras from tourist sites and beaches. That technology, Warren and Brandeis argued, 'invaded the sacred precincts of private and domestic life.' They referred, as support for that proposition, to an unreported case of Marion Manola, who in that same year brought an action in the New York Supreme Court for being 'photographed surreptitiously and without her consent.' That was notwithstanding the fact the photograph had been taken whilst she was performing on Broadway in public. Whilst photographing someone participating in a public spectacle could no longer be considered abnormal or offensive, the fact that Ms Manola was wearing stockings (tights) was enough for a court to consider the photograph sufficiently offensive to warrant an injunction preventing its sale or distribution and for Warren and Brandies to argue that 'the law must afford some remedy for the unauthorised circulation of portraits of private persons'. See Warren and Brandeis, above n 7; Robert E Mensel, '"Kodakers Lying in Wait": Amateur Photography and the Right of Privacy in New York, 1885-1915" (1991)

would have little reasonable expectation of having their image captured while transiting through a public place, and even less expectation of it being captured from above their house or property. Today digital technology is so ubiquitous that it is impossible to expect that one's image will not be captured wherever there is another person or whenever one is visible to the open sky.[64] Technology changes our sense of self and other's place in the world and how we interact with each other in it. It serves to modify our expectations, moral or otherwise and it changes what we are offended about, highly or otherwise.

There are, of course, times when the technological state of play is not particularly relevant to establishing an objective standard of what is reasonable or what is highly offensive; as I noted above, courts have taken into account a variety of considerations in this respect. In the précis we discussed the case of *United States v Knotts*,[65] in which the Court held that a tracking device installed in a car did not breach the occupant's privacy.[66] Key to that decision was the fact that a person travelling on a road could never reasonably expect not to be watched by others, or indeed monitored by authorities for legal compliance with road rules and the like. As such, the fact that an advanced technology had permitted a more efficient level of monitoring did not make the expectation of secrecy and privacy any more reasonable, or the fact that the occupant was being watched any more objectively offensive. Ultimately the relevance of the novelty or ubiquity of a technological surveillance system will turn on whether it dramatically alters the surveillance capacities of the surveillor in a manner which an ordinary person cannot be expected to have predicted or understood.

It is also true, that in some circumstances, common surveillance technologies, such as cameras with telescopic lenses, may capture information which an ordinary person may not have expected to be kept completely free from prying eyes, but which that person may have a reasonable expectation of privacy about nonetheless. As Davis notes, Campbell's case[67] was one of these situations.[68] However, the crux of the issue in *Campbell* was not the viewing so much as the disclosure *subsequent* to the viewing of a recognised category of confidential information — namely medical information about Campbell's rehabilitation — to third parties, who were not privy to the original viewing.

43(1) *American Quarterly* 24; Dorothy J Glancy, 'Privacy and the Other Miss M' (1990) 10 *Northern Illinois University Law Review* 401.

64 Hence, in US curtilage cases such as *Florida v Riley*, 488 US 445 (1989) and *Dow Chemical Co v United States*, 476 US 227 (1986) — which consider whether aerial surveillance of property breaches the right to privacy and the right against unlawful search — the court has been particularly concerned as to whether the surveillance equipment used was commonly available. Indeed, in the latter case the fact that the police used ordinary aviation and photographic equipment was in fact pivotal to the determination that the surveillance was legal.

65 460 US 276 (1983), 283.

66 Précis, above n 1, 129.

67 *Campbell v MGN* [2004] UKHL 22 ('*Campbell*').

68 Davis, above n 61, EAP 10.

That case has much less to do with surveillance as the transfer of data collated and recorded as a result of it. Indeed, as an equitable doctrine confidentiality law ordinarily only provides an injunction to restrain the use of the information collected, rather than punish or remedy for the damages caused in collecting it.

What these cases reveal, *in toto*, is that the common law can do very little to restrain state surveillance over public areas, and indeed private ones that are open to plain view from either the ground or on high. As most state surveillance data is not published to the world at large, there is little chance for people to argue their common law rights have been violated, because there is no evidence of harm, either to the person or their sensibilities. More to the point, the common law, particularly tort law, is remedial, not prospective; operating *ex-post-facto* to sanction past behaviour. It is not particularly adapted to limiting or controlling future behaviour in the absence of ascertainable or substantive proof of harm. Given that surveillance may occur without the knowledge of those watched, and in such situations, no person can claim to be more harmed than any other member of the community, such law is a poor mechanism to balance the competing social interests of privacy and security.

As I set out at the beginning of this commentary, the real harm, or at least the prevalent social harm arising from surveillance capacity saturation, is the fact that people simply don't know when, or if they are being watched, or for what purposes or how that information might affect them now or in their future lives. In the panoptic world it is the uncertainty about whether data is being collected which is most harmful, not the disclosure of that data to third parties *per se.* Moreover, the most overwhelming harm is to society as a whole — by undermining and eroding the fundamental institutions upon which it is based — rather than discrete individuals within it. Should we consider such harms detrimental to fundamental democratic values of freedom of thought, freedom of expression and freedom of association, then pre-emptive laws are required to limit the causative factor that reduces citizens' capacity or willingness to exercise these freedoms. In other words, it is proscriptive legislation, restraining state capacity to expand its surveillance capacities to, or close to saturation point which is required, not expanding or modifying civil law to remedy perceived harms once they occur.

4.1 Regulatory 'disarray'

As was noted previously however, despite long-standing academic debate and the derision of civil libertarians, the surveillance society has grown and expanded without a great deal of regulatory restraint. That is not to say no laws exist. Most countries do in fact have privacy and data protection laws, but their application to open, indirect surveillance is patchy at best. In the UK for instance, CCTV surveillance has generally been held to fall outside the *Data Protection Act*;[69] a rather strange oversight for the country in the world

69 Simon Chesterman, *One Nation Under Surveillance* (Oxford University Press, 2011) 150.

with the highest concentration of this form of surveillance device. Indeed, although Europe more generally is considered to have the most comprehensive privacy and data protection laws in the world — by virtue of the European Court of Human Rights and the Directive on Data Protection Privacy — *Privacy International* reported at the conclusion of 2011 that:

> Surveillance harmonisation [in Europe] that was once threatened is now in disarray. Yet there are so many loopholes and exemptions that it is increasingly challenging to get a full understanding of the privacy situations in European countries.[70]

Certainly the massive uptake in surveillance technologies by all forms of bureaucratic and security agencies make it particularly hard to ascertain just how much or where surveillance is occurring. *Privacy International* argues that the 'cloak of "national security" enshrouds many practices, minimises authorisation safeguards and prevents oversight'.[71] In the security conscious United States, the situation is equally bad, if not worse. Chesterman points to 'the many actors in the intelligence community', not to mention domestic law enforcement and state agencies operating surveillance devices in the United States who 'may pose accountability difficulties through sheer complexity … [and] fragmentation of authority can pose practical problems in ensuring appropriate oversight.'[72]

Indeed, although accountability mechanisms do exist, including cross-institutional regulatory regimes to 'watch the watchers', the focus of legislative restraint on surveillance has, centred upon the collection of surveillance data, especially in the audio visual realm.[73] As Solove argues, the problem with this situation is that:

> Surveillance is a different kind of privacy problem than disclosure, imposing a different type of injury to a different set of practices. Surveillance differs from disclosure because it can impinge upon practices without revealing any secrets. Being watched can destroy a person's peace of mind, increase her self consciousness and uneasiness to a debilitating degree, and can inhibit her daily activities.[74]

There is certainly very little regulatory consideration of the collective impact of the *process* of mass surveillance — as opposed to individual surveillance for

70 Privacy International, *European Privacy and Human Rights (EPHR) 2010 Privacy International*, the Electronic Privacy Information Center (2011) 11 <https://www.privacyinternational.org/Ephr>.

71 Ibid.

72 Chesterman, above n 69, 212.

73 Ibid 151.

74 Solove, above n 5, 1130.

the process of criminal investigation.[75] That is, it overlooks the monitoring and tends to only be concerned with what is done with the recorded data or how it is disclosed. Like the civil law, privacy legislation tends to be more concerned with individual rather than social harm. Equally problematic is the fact that legislation tends not to operate at the macro level, nor evaluate the level of state surveillance capacity in a whole-of-government sense.

The reality is that existing privacy and accountability legislative regimes are not, as of yet, appropriate regulatory devices to tip the balance from an appropriate level to saturation level surveillance capacity (assuming that there is a line to be drawn). That is, not least, because they are not so much concerned with surveillance capacity as post surveillance data use. Whilst the latter issue is extremely important in respect of privacy, the former has serious and profound implications for civil and democratic rights.

5 *Conclusion*

As has been discussed at length in the précis and a number of other commentaries, UVs do not create new issues *per se*, so much as extend the influence, capacities and reach of their controllers and thereby expand and compound the social and legal problems relating to their intended use. In respect of surveillance, they greatly magnify the surveillance capacity of those controlling them, most worryingly state institutions.

There are, of course, a range of benefits promised by UV technologies, not least for policing, law enforcement and public safety. But it is important not to forget that this is a technology developed in the theatre of war. We must also remember that it is a technology that promises to realise a panoptic vision originally designed around maintaining control over prison populations; albeit now on a much grander society-wide scale. Of course, we already live in a surveillance society, but UVs are the technology which may close the remaining gaps in the open spaces where people could previously expect to be 'left alone'.

Unlike CCTV cameras UVs are, more often than not, designed to be covert and undetectable. Even if CCTV is now almost so prolific that it is hard to avoid it completely in a public place, UVs now render void the theoretical idea that state surveillance can be avoided in public. Moreover, because this technology is unmanned there will certainly be no *time* when one can hope not to fall under the gaze of unsleeping eyes.

The world of UV surveillance is absolute, global and persistent and it threatens to turn civilian spaces into the panoptic prison of Bentham's imagination, if not a physical prison, a prison of the mind. That is because, as Tariq's story shows us, people living in a surveilled world must be constantly

75 This distinction is evident in Australia in the form of the *Surveillance Devices Act 2004* (Cth), which limits the capacity of law enforcement agencies to undertake electronic surveillance of suspects or as part of investigations.

on their guard about whom they meet, what they talk about and whether those interactions might be with persons or about subject matters that draw the attention of a hostile state.

It is, of course, easy to overstate the impact of new technologies. Once the moral panic subsides, we have, as a society proven remarkably adept at subsuming technological advances into everyday life in a way that maximises their social utility and benefit. However, successfully integrating novel technologies in a manner which maximises their benefits and reduces their risks requires foresight, consideration and effective debate. Such debate and deliberation works most effectively in advance of technological change, and certainly in advance of the social change that it brings. That is a lesson from the nuclear proliferation debate, which is particularly relevant to UV technology and one highlighted in the précis paper.[76] Even since that paper was written the world has proceeded further into a UV arms race; most recently with Asia increasing its research and production in the area. Unchecked, there will be equally wide proliferation of the technology in the civilian sphere given the strength of support by proponents and governments for are its — as Mary Ellen O'Connell describes — 'seductive' qualities;[77] in this case: scope, efficiency, cost savings and reach.

The point of this commentary was not to suggest where the line should be drawn for the use of UV technology in civil society, nor the regulatory mechanism to achieve it. Rather it was to point out some of the socio-legal risks of unfettered proliferation of UV technology should we not take some form of action.

I have argued that the law does very little to restrain the use or impacts of UVs by state authorities. Ultimately, at present, the only real brake on reaching near saturation point state surveillance capacity is the speed of the transition from military to civilian spheres. As Chesterman rightly notes '[t]he notion that courts will have a leisurely opportunity to consider the implications of new surveillance technologies and their use now seems quaint.'[78] The same is true of legislatures and society as a whole. That means we are running out of time for debate and running out of time for effective regulatory responses should the debate determine some limits are required. Ironically, the unfettered and unrestrained use of surveillance threatens the very democratic institutions which operate to ensure that debate is effective and truly representative. That, more than anything else should be a motivating factor for real commitment to regulatory deliberation on the use of UVs in civil society.

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76 Précis, above n 1, 142.

77 Mary Ellen O'Connell, 'Seductive Drones: Learning from a Decade of Lethal Operations' (2011) 21(1) *Journal of Law, Information & Science,* EAP 1, doi: 10.5778/JLIS.2011.21.OConnell.1.

78 Chesterman, above n 69, 154.