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Welcome to the future:
the use of drones in war

CLINTON FERNANDES explains the technological advances being made in unmanned vehicles and the challenges that arise from these developments.

FIVE MONTHS BEFORE THE September 11 terrorist attacks, an unmanned aircraft known as the Global Hawk left Edwards air force base in southern California and arrived a day later at RAAF Base Edinburgh in South Australia. Considerable publicity surrounded this flight: it was the first crossing of the Pacific Ocean by an unmanned aerial vehicle, and its ability to monitor more than 100,000 square kilometres over a day of continuous flying made it an ideal asset to patrol Australia's long northern coastline. While in Australia, the Global Hawk carried out a dozen experimental missions: it patrolled the skies over the Woomera test range and the southern and east coasts of Australia, tested its electro-optical and infra-red sensors, participated in Exercise Tandem Thrust (a multi-national military exercise), and conducted long-distance flights to test its performance in Australia's unique conditions. Publicity surrounding the Global Hawk's visits to RAAF Base Edinburgh came to an end after the wars in Afghanistan and Iraq began. But local aviation enthusiasts were able to track its visits for many years by monitoring the arrival of US Air Force transport aircraft such as the C-141 Starlifter, which unloaded shipping containers that contained the Global Hawk's command and control equipment. Australian authorities visited these local enthusiasts and told them not to publicise the presence of unmanned aircraft at RAAF Base Edinburgh.

Yet, despite the sensitivities, the insistence on secrecy and the novelty of unmanned aerial vehicles (UAVs), the fact is that they have been around for almost a century. Their existence and development have been driven by the desire—itself as old as warfare—to deliver lethal force to the enemy while protecting one's own troops. When you walk inside the National Museum of the US Air Force in Dayton, Ohio, you see the 'Bug'—a UAV designed in 1917 by Charles F. Kettering. Also known as the Kettering Aerial Torpedo, the Bug was launched from a four-wheeled dolly that flew according to a system of internal pre-set pneumatic and electrical controls, and was guided towards a target on the ground. It carried 180 pounds of explosives that detonated on impact. The Bug never saw combat but it was the ancestor of today's UAVs that are popularly known as drones: powered, aerial vehicles that fly autonomously and can carry a lethal or non-lethal payload. UAVs are often deployed as part of a system of as many as six drones, a ground control station, data links and support equipment.

THE FIRST COMBAT USE OF drones was during the US war against Vietnam when the Firebee AQM-34 was used in an intelligence collection role. The Firebee had previously served as an aerial gunnery target. Drones were later used successfully by Israel in the 1982 Lebanon war. The US then developed its drone programme by acquiring weapons platforms from Israel. It used the Predator drone in the Kosovo conflict in 1999, the Afghanistan war from 2001 onwards, and the Iraq war since 2003. Indeed, the first air-to-air combat encounter between a drone and a piloted aircraft has already occurred: a Predator drone attacked an Iraqi MiG with a Stinger missile in March 2003 but was shot down by the Iraqi pilot.

Drones can do things that piloted aircraft can't: they can fly without getting tired, feeling fear, losing concentration or risking pilots' lives. The Pentagon, which had 167 drones in 2002, now has nearly 8,000 in its inventory with funding for thousands more in the future. However, although drones are usually cheaper than piloted aircraft, they often carry very costly sensors and crash at a much higher rate than piloted aircraft, making even the well-funded Pentagon reluctant to view them as expendable. Their traditional mission remains intelligence collection. They were used for reconnaissance during the Vietnam War, and subsequently to carry cameras and fly above opposing forces to provide friendly forces with visibility beyond the direct line of sight. Technological advances have improved the endurance of modern drones, increasing their ability to conduct reconnaissance against far-away, mobile targets. Technology has also improved the stealth of modern drones: the classified RQ-170 Sentinel, also known as the Beast of Kandahar, is a low-observable drone that reportedly conducted surveillance and communication tasks during the raid on Osama bin Laden's compound in May 2011.[1] But technology works both ways: the GPS receivers in drones can be jammed or even spoofed, fooling the drone's navigation system into thinking that the false signal it is receiving is authentic. This is what the government of Iran claimed to have done in December 2011. Its electronic warfare specialists jammed the communications signal between the RQ-170 Sentinel and a satellite. They then reconfigured the Sentinel's GPS coordinates, feeding it data on altitude, latitude and longitude to make it think it was landing in Afghanistan, when it was really landing in Iran. For all the technical advances in endurance, sensors and firepower, the key vulnerability in drones remains the potential for interference and jamming of GPS signals. They can be overridden by more powerful signals from television towers, or spoofed so as to make them believe that they are somewhere other than where they actually are.[2]

Drones are also used in attack roles. Before major technical advances had been made, the way this was accomplished was by simply flying a drone in a particular direction until it ran out of fuel. It would crash on to whatever target it happened to be flying over at the time. But things have changed: today a drone may have a precision-guided weapon that has been configured to attack targets on the ground. In such a configuration, a drone is called a UCAV—unmanned combat air vehicle. The MQ-1 Predator is the best-known UCAV.[3] Fitted with electro-optical and infra-red cameras that enable it to perform surveillance and track moving targets day and night, and a special radar[4] that allows it to function in poor weather conditions, the Predator also carries two Hellfire missiles. It can therefore identify a target and carry out an attack by itself, rather than have to notify a different aircraft once it spots a target, which was previously the case. The MQ-9 Reaper has exceeded the Predator's attack capabilities, carrying 16 Hellfire missiles and possessing the ability to stay aloft longer and to fly much further.

As these attack drones improve in lethality and stealth, one concern is that the political barriers to war may be lowered. As the US political scientist Peter W. Singer has argued, 'the strongest appeal of unmanned systems is that we don't have to send someone's son or daughter into harm's way. But when politicians can avoid the political consequences of the condolence letter — and the impact that military casualties have on voters and on the news media — they no longer treat the previously weighty matters of war and peace the same way.'[5] The appeal of drones is best illustrated by their proportion to manned aircraft: in 2005, drones were only 5% of the Pentagon's total aircraft inventory. Today they are 31%, and the proportion is increasing.[6] No major Western aircraft manufacturer is developing any new manned combat aircraft. Meanwhile, the US Air Force is training more operators of drones than fighter and bomber pilots combined. And, although drones are being used against targets in Afghanistan, Pakistan, Yemen, Libya and elsewhere, the US Congress has never debated the issue of drone strikes even once. The effectiveness of the new technology has apparently removed the need for Congressional authorisation.

One wonders what the decision-making process in Australia will look like once we obtain UCAVs and integrate them into our inventory. For there is little doubt that we will obtain UCAVs in growing numbers once the RAAF's concerns about the future of its pilots are overcome. The drones' ability to fly without getting tired, losing concentration or risking pilots' lives makes them invaluable in the detection of drug smuggling, illegal fishing and illegal immigration. They would also be a vital component of Australia's surveillance and reconnaissance system, which includes the Airborne Early Warning and Control air surveillance systems, over-the-horizon-radars and maritime patrol aircraft. Only three years ago, the RAAF took delivery of two Heron unmanned reconnaissance aircraft from Israel for use in Afghanistan. The Heron package included the aircraft, electro-optical and infra-red cameras, ground control station, spare parts and ground support equipment. In addition, British Aerospace has been testing its Mantis medium-altitude long-endurance UAV demonstrator over the Woomera test range for some years, and Australian defence planners are monitoring its performance keenly.

FOR A MARITIME NATION LIKE Australia, the ability to deploy underwater unmanned vehicles (UUVs) or naval drones as part of the fleet will grow in strategic importance. If past and current practice is any indication, we will acquire UUVs from the US, which today has about 500 in its military inventory. Currently, naval drones are small vessels that gather oceanographic data and survey the ocean bed in search of mines. Prominent among these is the Mk18 family of UUVs that are equipped with side-scan sonar technology and a camera. It includes the Swordfish, which is only seven inches in diameter and weighs 80 pounds. A small device like this operates at depths no greater than 40 feet, where the water is very muddy and detection capabilities are severely tested. Its larger relative, the Kingfish, is only 12 inches in diameter and is designed for operation at somewhat greater depths.[7] In future, however, there are expected to be much larger unmanned naval vessels that will operate for just over two months continuously. Considerable amounts of money are being poured into research to increase the endurance and power of naval drones, as well as their ability to operate in unforgiving maritime conditions. It is no easy feat to ensure the reliability of cutting-edge electronics in turbulent water, where extreme pressure and corrosion must be overcome without human intervention for weeks or months at a time.

The limiting factor at the moment is energy. Intensive research is currently being carried out on emergent technologies such as fuel cells. The US Navy is particularly interested in a hybrid Solid Oxide Fuel Cell (SOFC)-Battery power system that may one day be able to supply electricity for a 70-day unmanned underwater mission. The main complicating factor in the underwater context is that engineers need to work out not only how to increase the battery's endurance but also how to carry an oxidiser in a confined section in the undersea vessel. Above the water and on land, traditional and portable fuel-cell vehicles can use the oxygen in the air. Since this is simply impossible underwater, the challenge is to carry an oxidiser in order to make the fuel cells work. Mobility and endurance will be limiting factors for unmanned undersea vehicles until these battery problems are solved.

Australia, with its vast maritime responsibilities, will be keenly interested in UUVs that can be deployed and left in position for weeks or months at a time. One solution, still on the horizon, may be to turn ocean sediment into fuel. Research has already begun into microbial fuel cells that generate electricity using oxygen and organic material from the ocean. They harvest the metabolic activity of microbial organisms that live in the mud on the ocean

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floor, then transfer the energy to a fuel cell so as to power the electronics on an unmanned system or sensor. This means that sensors and unmanned systems would no longer be reliant on conventional batteries that run down; they would run on batteries that could recharge themselves without human intervention. In fact, the microbial fuel cell concept has already been proven in small-scale laboratory tests.[8] The challenge is to make it work in the field. If this occurs, an environmentally sustainable power source with much wider applicability than war-fighting will have been created.

Chinese researchers are at the forefront of developing other ways to solve the underwater energy problem: underwater gliders that adjust their buoyancy by pumping gas in or out of an external bladder and gliding a shallow path as it rises or falls. Since they don't have propellers, the average speed is only half a knot, but gliders can cross oceans and carry out missions that last several months. These underwater gliders have practically no military uses at the moment; they are only about six feet long and weigh 100 pounds. In future, however, it is quite likely that technological developments in computing and sensors will make these gliders valuable assets in long-endurance surveillance missions.

A MAJOR AREA OF INTEREST for Australian naval planners is how to deal with mines. Unmanned vessels can be very useful here, since the long-term goal is to 'take the man out of the minefield.' In the US Navy, different unmanned vehicles perform different tasks within the chain of events for mine hunting: specific vehicles are used to find a potential threat, identify and classify it, mark its location and neutralise it. This is quite a complicated, time-consuming endeavour. As such, the US Navy is working on an unmanned surface-based vehicle that can detect, identify and neutralise a mine in a single sortie. Such a naval drone would combine the whole kill chain into one integrated, autonomous system. This future naval drone will possess enhanced identification capability since it is very costly to deploy a $100,000 neutraliser to a suspected mine only to find that it was not a mine after all.[9] At the moment, the Royal Australian Navy operates three mine countermeasure drones within its so-called 'Craft of Opportunity' program that fits commercial fishing vessels with side-scan sonars and influence sweeps.[10] However, the majority of its mine countermeasure work is done by six new Huon-class mine-hunters and two auxiliary minesweepers dating back to 1982. Once the technology is available, naval drones will be ideally suited to deal with mines.

The Royal Australian Navy, like the United States Navy, is all too aware that China's navy views the submarine delivery of mines as an essential part of its offensive and blockade operations. According to US naval strategist Scott Truver, the mass deployment of mines is perhaps the most common submarine tactic used by China's navy.[11] Unlike the western navies, which tend to view mine-laying as secondary to their real missions, China's navy trains extensively in submarine operations that deploy large numbers of mines in shallow locations, choke points and deep water. The reason for China's use of massed mine warfare is the disproportionate effect they have: in 1950, the US-led United Nations amphibious task force off the east coast of North Korea was severely hampered by the deployment of more than 3,000 mines that were laid within only a few weeks. The task force's mine counter measure forces suffered more than 20% of all naval casualties even though they accounted for only 2% of all United Nations naval forces. Rear Admiral Allan Smith, who was in command of the advance force, said: 'We have lost control of the seas to a nation without a Navy, using pre-World War I weapons, laid by vessels that were utilised at the time of the birth of Christ.'[12] More than 40 years later, Iraqi forces laid more than 1,300 mines in the Persian Gulf despite the presence of multinational coalition naval forces. This tactic ensured that the US Navy lost command of the northern Persian Gulf in February 1991. Two Navy warships were crippled, and US commanders decided not to go ahead with an amphibious assault for fear of more casualties.[13] As the energy, stealth and identification capabilities of naval drones increase, they will be frequently deployed in the dirty, dangerous tasks of mine countermeasures. They will be especially useful before hostilities actually break out, gaining knowledge of the battlespace in a less provocative manner than a manned vessel. Political decision-makers thus gain the flexibility to de-escalate, if they so choose, without a loss of face for anyone.

WELL INTO THE FUTURE, as technology continues to improve, it is quite likely that naval drones will be used in anti-submarine warfare. Formidable challenges will have to be met before this can occur, however: unlike their aerial counterparts, naval drones cannot be easily controlled from a distance because communication links are severely affected by water currents, shipping traffic and obstacles on the ocean floor. A recent trial has been promising: a test vehicle has just completed a 26 hour voyage, plotting its own course without relying on GPS or any other communications. Guiding itself by features on the sea floor, it passed through the pylons of a bridge, circumnavigated an island and surfaced in a pre-determined spot inside a harbour. In this test voyage off the east coast of the US, the waters were shallow with complex, varied features on the bottom and a lot of commercial traffic: an ideal testing environment.

Drones are a new answer to a problem that has been posed since the very beginnings of armed conflict: how to kill your enemy while minimising the risk to your own troops. They will represent challenges and opportunities in civilian life too: thousands of drones will be flying at various altitudes over Australian skies within 20 years. They will create challenges not just for air safety but also for privacy and civil liberties. Since they allow police forces to engage in surveillance without necessarily conducting the kind of search that usually requires a warrant, they will pose new questions as to what a reasonable expectation of privacy actually means. Further discussion and debate will be required so as to not alter the balance between the state and the individual to the detriment of the latter.

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FOOTNOTES

[1] RQ stands for Reconnaissance Unmanned.

[2] N. Tippenhauer, C. Popper, K. Rasmussen, S. Capkun, *On the Requirements for Successful GPS Spoofing Attacks*. http://www.syssec.ethz.ch/research/ccs139-tippenhauer.pdf

[3] MQ stands for Multi-mission Unmanned.

[4] Synthetic aperture radar (SAR).

[5] P.W. Singer, Do drones undermine democracy? *New York Times*, 21 January 2012.

[6] J. Gertler, U.S. *Unmanned Aerial Systems*, Congressional Research Service, 3 January 2012.

[7] Megan Eckstein, Mk 18 Underwater Explosives Detector To Help Cut Down EOD Time Line, *Inside Defense*, 31 August 2012.

[8] Microbial Fuel Cell: A New Source Of Green Energy, 19 April 2010: http://www.redorbit.com/news/science/1851900/microbial_fuel_cell_a_new_source_of_green_energy/

[9] Megan Eckstein, ONR Seeking USV To Detect And Neutralize Mines As Part Of LCS Package, *Inside Defense*, 11 September 2012.

[10] Influence mine-sweeping consists of simulating the magnetic, acoustic or other signatures of a ship so that a mine detonates harmlessly. It requires technical intelligence on the operation of sensors, firing triggers and counter-measures.

[11] Scott C. Truver, Taking Mines Seriously: Mine Warfare in China's Near Seas, *Naval War College Review,* Spring 2012, Vol. 65, No. 2.

[12] Tamara Moser Melia, "Damn the Torpedoes": A Short History of U.S. Naval Mine Countermeasures, 1777—1991, Contributions to Naval History 4 (Washington, D.C.: Naval Historical Center, 1991);

[13] Scott C. Truver, Ibid.