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Understanding the drone epidemic

Roger Clarke [a,b,c,*]

[a] Xamax Consultancy Pty Ltd, Canberra, Australia
[b] Australian National University, Canberra, Australia
[c] University of N.S.W., Sydney, Australia

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ABSTRACT

Drones are aircraft that have no onboard, human pilot. Through the twentieth century, piloted aircraft made far greater progress than drones. During the twenty-first century, on the other hand, changes in both drone technologies and drone economics have been much more rapid. Particularly in the case of small, inexpensive devices, the question arises as to whether existing regulatory frameworks can cope. To answer that question, it is necessary to document the nature and characteristics of drones, the dimensions across which they vary, the purposes to which they are put, and the impacts that they appear likely to have. The analysis concludes that careful consideration is needed of the adequacy of controls over the impacts of drones on two important values – public safety, and behavioural privacy.

1. Introduction

During the twentieth century, people became used to seeing vehicles in the sky. As had been the case with horse-drawn carriages, train engines, trams and automobiles, a human in the airborne vehicle controlled its behaviour. The twenty-first century is seeing a rapid proliferation of aerial vehicles that do not have a human controller on board. In some cases, the pilot is nearby, and in others the pilot is remote and even half-a-world away. Large drones are being used for military purposes by various countries. Meanwhile, the capabilities of small drones have greatly increased, and their manufacturing costs have greatly reduced. So small drones are proliferating, the increase in market-size has attracted further investment, and a leap in the functionality-to-cost ratio has occurred. This multiplies the potential for benefits from drones, and exacerbates the risks.

In addition, a century of technological progress has resulted in at least some of the pilot's functions being performed automatically, particularly aircraft stability in response to turbulence. Autonomy may extend through various levels, under human supervision or otherwise, with or without automatic detection of out-of-scope conditions and auto-handover to a human pilot, and subject to over-ride by the human pilot or not. With such capabilities come risks.

Can existing regulatory frameworks cope with the challenges arising from increased capabilities, much greater usage, and higher degrees of drone autonomy? To answer that question, it is necessary to document the nature and characteristics of drones, the dimensions across which they vary, the purposes to which they are put, and the impacts that they appear likely to have.

Many parties have an interest in talking up drones and their capabilities and applications. Many media outlets are driven by the need for revenue, and subject to limited journalistic constraints, so a great deal of the media coverage of drones comprises lightly dressed-up versions of corporate sales brochures and media releases, with limited critical thought applied by the nominal author. The implications of drones are sufficiently significant that more careful analysis is needed.

* Xamax Consultancy Pty Ltd, 78 Sidaway St, Chapman ACT 2611, Australia.
E-mail address: Roger.Clarke@xamax.com.au.
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The privacy impacts of civil applications of drones have already been subjected to analysis, e.g. in Finn and Wright (2012). The scope of the research reported on here is broader than privacy, extending across the wide range of security issues that the technologies give rise to. This is the first of a series of four papers, whose combined purpose is to identify the disbenefits and risks in the use of drones, and consider the extent to which they are subject to suitable controls.

The present paper lays the foundation for the series. The second paper reviews the existing literatures on computing, data communications, robotics, cyborgisation and surveillance, in order to bring past experience to bear on the drone phenomenon. The third and fourth papers examine the extent to which current regulatory frameworks for public safety and behavioural privacy appear likely to cope, and the prospects of adapted and new measures to address the problems that drones present.

The scope of the work is civilian applications and excludes theatres of war. Issues that are thereby out-of-scope include the ethics, politics and practices of remote-controlled delivery of armed explosives, the notion of 'war as video game', the 'post-heroic' age of warfare, the increasing acceptability of warfare with limited risk to the war-maker's personnel, the role of drones in the quiet creep of war-making by countries' executives outside the control of their parliaments, and violence committed by semi-autonomous devices on behalf of nation-states.

It is necessary, however, to keep warfare at least somewhat within the field of view. Military applications have been, and remain, a strong driver of drone developments. The vast sums of money available for research, IR&D and production of equipment that provides military advantage heavily biases progress in particular directions. A further factor is that the early years of the 21st century have seen a dramatic increase in the application of military technologies by nation-states not only to wage war on other nations that they perceive to be enemies at the time, but also to monitor activities along the country's borders, to assist in the enforcement of domestic laws, and even to subjugate their own people. The scope of this series of articles accordingly encompasses not only individual, corporate and governmental applications of drones, but also law enforcement and national security uses within an individual country.

The industry prefers to use descriptive terms for the aircraft concerned, but this paper uses the popular term throughout. The paper commences by reviewing the emergence of drones, and their attributes. On the basis of a consideration of categories of drones and not-drones, and boundary-testing examples, a working definition is proposed. The opportunities and challenges that drones present are then considered within a wide range of current and proposed application-areas. This delivers insights into the question of the attributes of drones that challenge existing regulatory arrangements.

2. Drones

In order to develop an appropriate working definition for a drone, this section considers in turn their precursors and origins, and the attributes of effective drones, with particular attention paid to their control and the degree of autonomy from their controller.

2.1. *Emergence*

Many threads of technological development have fed into the notion of a drone. Artefacts have been airborne for several millennia (in such forms as sharpened stones, spears, boomerangs and kites). Humans have been achieving flight since at least 1783, using lighter-than-air balloons or 'aerostats'. Powered flight was achieved by a French 'dirigible' balloon in 1852. The internal combustion engine was applied by 1872, with most of the early developments taking place in France and then Germany. Nearly 150 years later, aerostats were tethered 15,000 feet above Afghanistan, transmitting live battlefield-surveillance video (Bumiller and Shanker, 2011). Heavier-than-air craft were emergent through the nineteenth century in several countries. Following developments during the 1890s, the first fixed-wing aeroplane/airplane achieved sustained, manned, powered and controlled flight in the USA probably in 1901 and certainly in 1903. Rotorcraft (of which the helicopter is the most common form) had been emergent for centuries, with the first unmanned flight in 1877 in Italy, and the first manned flight in 1907, in France.

Flying artefacts have been applied to many purposes. One early use, at least 2000 years ago, in China, was to assist in communications by means of lanterns. Balloons were used to carry human observers by the French in 1794, and this use was revived during the American Civil War in 1861–65. Cameras were attached to balloons in France in 1858, to kites and rockets c. 1880–1900, and to pigeons in Germany in 1907–11. Drones were being developed as means of carrying weapons and delivering explosives as early as 1915 in the USA, and were used as targets as early as 1930 in the UK. Science fiction has played an interactive role with many technologies, including drones. The first major 20th-century anti-utopian novel – 25 years before Orwell's '1984' – imagined drones ('aeros') as the means by which the government observed and repressed the population (Zamyatin, 1922). The surveillance and security applications of micro-drones were investigated in Stephenson (1995).

Many forms of motive power have been the subject of experimentation, and some have been harnessed. A greater challenge in the development of drones has been the means of control of the aircraft. The early focus was on control by a human pilot on board the aircraft, and, for the first century of flight, pilotless aircraft were seen as exceptions and novelties rather than the mainstream.

Yet remote control of transport devices had emerged before the first manned flight, in the form of Tesla's Teleautomaton – a radio-controlled boat, demonstrated in 1898. Automated stabilisation control of an aircraft was emergent in the USA in 1910–15. The first known pilotless rigid-frame aircraft was in testing in the USA prior to the end of the World War I.

Generally, discussions of drones refer to an individual, at distance from the drone, but in control of it. The term 'remote pilot' is commonly used, not just for historical reasons, but also because the functions performed and the visualisation