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The Future of Drone Use

Opportunities and Threats from Ethical and Legal Perspectives

Bart Custers *Editor*

Springer

Information Technology and Law Series

Volume 27

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ISSN 1570-2782 ISSN 2215-1966 (electronic)
Information Technology and Law Series
ISBN 978-94-6265-131-9 ISBN 978-94-6265-132-6 (eBook)
DOI 10.1007/978-94-6265-132-6

Library of Congress Control Number: 2016945865

Published by T.M.C. ASSER PRESS, The Hague, The Netherlands www.asserpress.nl
Produced and distributed for T.M.C. ASSER PRESS by Springer-Verlag Berlin Heidelberg

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer-Verlag GmbH Berlin Heidelberg

Series Information

The *Information Technology & Law Series* was an initiative of IT*e*R, the national programme for Information Technology and Law, which was a research programme set up by the Dutch government and The Netherlands Organisation for Scientific Research (NWO) in The Hague. Since 1995 IT*e*R has published all of its research results in its own book series. In 2002 IT*e*R launched the present internationally orientated and English language *Information Technology & Law Series*. This well-established series deals with the implications of information technology for legal systems and institutions. Manuscripts and related correspondence can be sent to the Series' Editorial Office, which will also gladly provide more information concerning editorial standards and procedures.

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Acknowledgments

Publishing a book is a considerable effort. This book could not have been published without the help of many people. The editor would like to thank all the authors and reviewers who contributed to this book. The reviewers are, in alphabetical order: David Bergman, Nicholas Brown, Marc Coeckelbergh, Quirine Eijkman, Rachel Finn, Luisa Marin, Sophia Michaelides-Mateou, Alan McKenna, Jan-Jaap Oerlemans, Walter Parlevliet, Timothy Ravich, Helena Ursic, Bas Vergouw, Tal Zarsky and Wim Zwijnenburg.

Some authors also provided help with the further editing of some chapters. Special thanks are addressed to Alan McKenna, David Wright and Sally Applin. Furthermore, special thanks are addressed to Simone van der Hof, editor-in-chief of the book series of which this book is part, and to Frank Bakker, Kiki van Gurp and the rest of the team of Asser Press for their support in getting our work published.

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About the Editor

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Benjamyn Scott graduated in 2011 in Law with European Legal Studies at the University of Kent and the University of Amsterdam LL.B. (Hons). He then went on to study for an LL.M. in International Commercial Law at the University of Kent

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Abbreviations

ACLU	American Civil Liberties Union
ACPO	Association of Chief Police Officers
ADCO	Administrative Co-operation
ADS-B	Automatic Dependent Surveillance Broadcast
AED	Automated External Defibillator
AGL	Above Ground Level
AI	Artificial Intelligence
ANAC	Administración Nacional de Aviación Civil (Argentina)
ANAC	Agéncia Nacional De Aviaco Civil (Brazil)
ANO	Air Navigation Order (UK)
ANSPs	Air Navigation Service Providers
ASD	Aeronautical Systems Center
ATM	Air Traffic Management
ATT	Arms Trade Treaty
BALPA	British Airline Pilots Association
BC10	Beijing Convention 2010: Convention on the Suppression of Unlawful Acts Relating to International Civil Aviation. ICAO Doc. 9960
BD	Big Data
BP10	Beijing Protocol 2010: Protocol Supplementary to the Convention for the Suppression of Unlawful Seizure of Aircraft. Doc 9959
BS	Border Surveillance
BYTE	Big data roadmap and cross-disciplinary community for addressing societal externalities
C2C	Command and Control
CAA	Civil Aviation Authority
CAD	Civil Aviation Department (Hong Kong)
CC44	Chicago Convention 1944: Convention on International Civil Aviation. 61 Stat. 1180; 15 UNTS 295
CCTV	Closed Circuit Television
CEO	Chief Executive Officer

CEPT	Conférence Européenne des Administrations des Postes et des Télécommunications
CERA	Canterbury Earthquake Recovery Authority
CIA	Central Intelligence Agency
CISE	Common Information Sharing Environment
CJEU	European Court of Justice
CNIL	Commission nationale de l'informatique et des libertés (France)
CNPC	Control and Non Payload Communications
COA	Certificates of Waiver or Authorization
COE	Council of Europe
COIN	Counter-Insurgency/Counter-Terrorism
COSME	EU programme for Competitiveness of Enterprises and Small and Medium-sized Enterprises
CPIP	Common Pre-Frontier Intelligence Picture
CSDP	Common Security and Defense Policy
DAA	Detect and Avoid
DARPA	US Defense Advanced Research Projects Agency
Decea	Department of Airspace Control (Brazil)
DGCA	Directorate General of Civil Aviation (France)
DG CNCT	EU Directorate General for Communications, Networks, Content and Technology
DG ENTR	EU Directorate General for Enterprise and Industry
DHL	DHL Express
DNA	Deoxyribonucleic Acid
DOT	US Department of Transportation
DPA	Data Protection Authority
DPIA	Data Protection Impact Assessment
EASA	European Aviation Safety Agency
EC	European Commission
ECA	European Cockpit Association
ECAC	European Civil Aviation Conference
ECC	Electronic Communications Committee
ECHR	European Convention on Human Rights
ECTHR	European Court of Human Rights
EDA	European Defense Agency
EDPS	European Data Protection Supervisor
EEAS	European External Action Service
E-ES	Entry-Exit System
EMC	Electro Magnetic Compatibility
ENG/OB	Electronic News Gathering and Outside Broadcasting
ERC	European Radio Committee (former ECC)
EREA	European Research Establishments in Aeronautics
ESA	European Space Agency
ESP	European Situational Picture
ETA	Euskadi Ta Askatasuna (Basque nationalist and separatist organization)

EU	European Union
EUBAM	EU Border Assistance Mission
EUROCAE	European Organisation for Civil Aviation Equipment
EURODAC	European Dactyloscopy, the European fingerprint database
EUROSUR	EU external border surveillance system
FAA	Federal Aviation Administration
FATA	Federally Administered Tribal Areas (Afghanistan and Pakistan)
FBI	Federal Bureau of Investigation
FedEx	Federal Express
Frontex	EU Agency for external border cooperation
FSS	Fixed Satellite Services
GDPR	EU General Data Protection Regulation
GIS	Geographic Information System
GMES	Global environmental monitoring and security related operations
GPS	Global Positioning System
HOT	Humanitarian OpenStreetMap Team
HVT	High Value Target
ICAO	International Civil Aviation Organization
ICO	Information Commissioner's Office (UK)
ICRC	International Committee of the Red Cross
ICT	Information and Communication Technologies
IFRC	International Federation of Red Cross and Red Crescent Societies
IHL	International Humanitarian Law
IHRL	International Human Rights Law
ILT	Human Environment and Transport Inspectorate (Netherlands)
IMO	International Maritime Organization
IOM	International Organization for Migration
IS (ISIL/ISIS)	Islamic State (of Iraq and the Levant)
ISAF	International Security Assistance Force
ISO	International Organization for Standardization
ISR	Intelligence, Surveillance and Reconnaissance
IT	Information Technologies
ITU	International Telecommunication Union
JARUS	Joint Authorities for Rulemaking on Unmanned Systems
JSOC	Joint Special Operations Command
kg	kilogram
LARs	Lebanese Aviation Regulations
LED	Light-Emitting Diode
LIBE	Civil Liberties, Justice and Home Affairs
MA	Manned Aircraft
MALE	Medium Altitude Long Endurance Drone
MAV	Micro Aerial Vehicle
MC99	Montreal Convention 1999: Montreal Convention for the Unification of Certain Rules for International Carriage by Air. 2242 U.N.T.S. 309; S. Treaty Doc. No. 106-45
MH	Mental Health

MHz	Megahertz, one million hertz
MONUSCO	UN Stabilization Mission in the Democratic Republic of the Congo
mW	Milliwatt, one thousandth Watt
NCB	Nuclear, Chemical or Biological weapons
NCC	National Coordination Centres
NGO	Non-Governmental Organisation
NLRC	Netherlands Red Cross Society
NRA	National Regulating Authority
NYU	New York University
PbD	Privacy by Design
PETs	Privacy Enhancing Technologies
PIA	Privacy Impact Assessment
PII	Personally Identifiable Information
PTSD	Post-Traumatic Stress-Disorder
R&TTE	Radio and Telecommunications Terminal Equipment
RC52	Rome Convention 1952: Convention on Damage Caused by Foreign Aircraft to Third Parties on the Surface. ICAO Doc. 7364/310 UNTS 182
RCMP	Royal Canadian Mountain Police
RED	Radio Equipment Directive
RFID	Radio Frequency Identification
ROA	Remotely Operated Aircraft
RPA	Remotely Piloted Aircraft
RPAS	Remotely Piloted Aircraft Systems
RR	Radio Regulations
RTP	Registered Travelers Program
SAR	Search and Rescue
SARPs	Standards and Recommended Practices
SBC	Schengen Borders Code
SES	Single European Sky
SESAR JU	Single European Sky ATM Research – Joint Undertaking
SIA	Societal Impact Assessment/Social Impact Assessment/ Surveillance Impact Assessment
SIGINT	Signal Intelligence
SIS	Schengen Information System
SME	Small and Medium Enterprise
SMS	Short Message Service
SOLAS	Convention on the Safety of Life at Sea
SUA	Small Unmanned Aircraft
TC	Third Countries
TCA	Third Country Assistance
TNT	Trinitrotoluene (explosive material)
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System/Unmanned Aerial System

UAV	Unmanned Aerial Vehicle
UCAV	Unmanned Combat Aerial Vehicle
UGV	Unmanned Ground Vehicle
U-Haul	Self-moving truck band
UK	United Kingdom
UN	United Nations
UN OCHA	United Nations Office for the Coordination of Humanitarian Affairs
UNCLOS	UN Convention on the Law of the Sea
UNITAR	UN Institute for Training and Research
UNOSAT	UN Operational Satellite Applications Program
UPS	United Parcel Service
US	United States
USPS	United States Postal Service
UVSI	Unmanned Vehicle Systems International
VIP	Very Important Person
VIS	Visa Information System (Schengen)
VLOS	Visual Line of Sight
WC29	Warsaw Convention 1929: Convention for the Unification of Certain Rules Relating to International Carriage by Air. 49 Stat. 3000; 137 LNTS 11
WRC	World Radio Conference

Part I
Introduction

Chapter 1
Drones Here, There and Everywhere
Introduction and Overview

Bart Custers

Abstract This chapter provides an introduction to this book and an overview of all chapters. Given the popularity of drones and the fact that many of them are easy and cheap to buy, it is generally expected that the ubiquity of drones will significantly increase within the next few years. This raises questions as to what is technologically feasible (now and in the future), what is acceptable from an ethical point of view and what is allowed from a legal point of view. Drone technology is to some extent already available to consumers and more drone technologies are expected to become available to consumers in the near future. The aim and scope of this book: to map the opportunities and threats associated with the use of drones and to discuss the ethical and legal issues of the use of drones. Since drones have many names, including UAVs, UASs and RPASs, the terminology used is explained. This chapter concludes with an overview of the structure of this book, containing chapters on drone technology, the opportunities and threats of drone use, ethical and legal issues concerning the use of drones and potentials solutions for these issues.

Keywords Drones · UAV · UAS · RPAS

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B. Custers (ed.), *The Future of Drone Use*, Information Technology and Law Series 27, DOI 10.1007/978-94-6265-132-6_1

Contents

1.1 The Rise of Drones

Mrs. Lisa Pleiss lives in Seattle on the 26th floor of an apartment building. In June 2014 she looked out of her window and saw a drone that seemed to react to her gaze. It appeared to her that there were video cameras on the drone. Mrs. Pleiss was surprised and immediately distressed. Since Mrs. Pleiss lives on the 26th floor, she previously never had to worry about someone peering into her apartment. When she alerted the building management to the presence of the drone, they observed two men outside the building who seemed to be the ones operating the drone. The men quickly disappeared when they saw the management observing them. In the city of Seattle, drones are currently legal to fly, but are not permitted to photograph the inside of someone's home.[1]

In October 2014, two Dutch filmmakers in the Dutch city of Utrecht used a drone to take stunning pictures of the Dom tower, which was surrounded by mist.[2] The Dom is the tallest church spire in the Netherlands, built between 1321 and 1382. The owner of the drone used by the filmmakers received a fine of 350 Euro for using it to photograph the tower. According to Dutch laws, it is illegal to fly a drone without special permission. Furthermore, private drone owners are only allowed to fly drones during the day while the drone is operated in visual line of sight at all times. Additionally, drones may not fly above buildings and people.

In early 2015, people started to report drone sightings over Paris.[3] More than a dozen drone sightings over sensitive areas of the French capital were reported to the police. The flights reportedly took place overnight near the river Seine, Place de la Concorde, the Invalides military museum and around the Paris ring-road. Perhaps more worrying, drone sightings were reported over French nuclear plants

[1] Bradwell 2014.

[2] http://www.dutchnews.nl/features/2014/11/the-dom-tower-in-utrecht-by-drone/. Accessed April 1, 2016.

[3] http://www.theguardian.com/world/2015/mar/04/drone-sightings-paris-seine-concorde-invalides. Accessed April 1, 2016.

since October of 2014. For some time, it was unclear whether the drone flights were the work of pranksters, tourists or terrorists. However, in early 2015, the police arrested Al Jazeera journalist Tristan Redman, who was fined 1000 euro.[4]

The examples above illustrate the rise of drones in the public space. Civil drones are a relatively new phenomenon in our society. Previously drones were mostly employed in the military domain, for warfare in remote zones in places such as Afghanistan. The use of drones in the military domain got the discussion on drone use started and constituted the basis of the civil market for drones. As a result, these days small drones for civil (non-military) use are increasingly available for purchase by civilian consumers, because they are increasingly inexpensive and easy to buy. For less than a hundred euros, small drones can be purchased in toy stores or via the Internet. For a couple of hundred euros more, one can buy professional drones with advanced photo and video cameras. Most of these small non-military drones for sale to consumers weigh up to several kilograms and can fly within a range of a couple of meters to a several hundred meters.

The *possibilities* for the use of drones can be found in virtually all sectors of society. In the public sector drones can be used in the prevention of crime, in making reconstructions of crime scenes, in countering disasters, for dike inspections, geological surveys,[5] countering fraud, guarding borders,[6] and for environmental and agricultural inspections.[7] In the private sector there is potential for camera applications, to make aerial photographs, to help prevent neighbourhood crime and to support population census estimations. Drones also offer greater possibilities in the field of cinematography, television and other entertainment.[8] Additionally, there are numerous potential applications for drones equipped with various payloads, such as drones with heat sensors to detect cannabis plantations, drones that carry water, food or medicine for rescue operations, and drones with pesticides for use in agriculture. In the military domain, drones are used for several purposes, including deployment in conflicts.

The potential of drones is offset by the *threats* that make drones the target of damage, the means of inflicting damage, or an environmental factor responsible for damaging effects. Some people may deliberately try to damage or steal drones or their payloads, including collected data. Others may use drones as a means of inflicting damage, such as (intentional) security or privacy threats, using drones to collide with people or objects,[9] to drop certain (hazardous) payloads,[10] and to spy on other people or annoyingly monitor them. Non-intentional environmental

[4] BBC News 2015.

[5] Parker 2014; Dillow 2013.

[6] Caroll 2014; Stewart 2014; Preston 2014.

[7] Wozniacka 2013.

[8] CBS News 2014.

[9] Heine 2013.

[10] Chosun 2014.

safety risks include various threats regarding air traffic (crashing, colliding, etc.).[11] Drones may violate privacy in different ways, e.g., by harassing people (or, at the least, causing nuisance and annoyance), by their large-scale (legal or illegal) collection of personal data, inadequate transparency regarding what data are collected and how that data are used. Drones are also subject to 'function creep' (using data for purposes other than those for which they were originally collected).[12] In the military domain, drone use may cause civilian casualties.

Given their popularity and low cost, drones will become significantly more ubiquitous in the next few years. This raises questions as to what is technologically feasible (now and in the future), what is acceptable from an ethical point of view and what is allowed from a legal point of view. Drone technology continues to evolve. In support of further research and debate, this book aims to map the opportunities and threats associated with the use of drones and to discuss their ethical and legal implications.

This chapter provides an introduction to this book and an overview of the chapters that will follow. This first section briefly introduces the premise of this book, including its scope and intended audience, and what inspired us to write it. Section 1.2 provides a brief history of drones. Next, Sect. 1.3 describes the terminology used in this book (since drones are referred to in many ways, including terms such as UAVs, UASs and RPASs).[13] Finally, Sect. 1.4 sketches the structure of this book and introduces all chapters that follow.

1.1.1 What This Book Is About

This book aims to map the opportunities and threats associated with the current and future use of drones and to discuss the ethical and legal issues of drone use. As such, this book is useful as a reference for further research and debate, such as directions for desirable or undesirable technological developments, necessary, useful or unwanted applications of drones and possible regulation of drone technology and drone use.

The scope of this book includes existing drone technology and drone practices as well as technologies and applications under development or expected to materialize within the next 5–10 years. In Chap. 2, technological developments such as further miniaturization, increased flight autonomy and the use of swarms of drones are discussed.

Although this book provides information about drone technology in order to understand possibilities and threats and the ethical and legal issues raised by

[11] CASA 2013.

[12] See also Finn et al. 2014.

[13] UAV: Unmanned Aerial Vehicle, UAS: Unmanned Aircraft (or Aerial) System, RPAS: Remotely Piloted Aircraft System.

drones, it does not primarily have a technological focus. Rather, it deals with the social, ethical and legal effects of drone technology. The societal effects are discussed in terms of opportunities and threats. Ethical issues are discussed in terms of which types of drone use may violate important moral values and principles, which moral conflicts may occur and which types of drone use may call for applying moral principles in new ways. Legal issues are discussed in terms of analyses of current legal frameworks (what is allowed?) and envisioned legal frameworks (what should be allowed?). Ethical, legal and societal issues relate to, inter alia, privacy, trust, liberty, dignity, equality and possible chilling effects resulting from drone use.

Countries have different viewpoints on and different legal regimes for drone use. The authors contributing to this book present perspectives from different countries. However, since drone technology is an international development (drones are often and easily sold across borders), many of the opportunities, threats and ethical and legal issues discussed are universal. For example, many legal issues are the same across different jurisdictions. For example, aviation laws have a strong international orientation and many countries apply similarly strict regulations that aim to prevent a too liberal use of drones, mainly for reasons of air traffic safety. Simultaneously, many countries are studying whether the regulations are sufficient to cope with current and future developments, and are debating which types of drones use should be permitted. There are no real frontrunners here. Most Western countries are still debating drone use and possible amendments to rules and regulations.

Due to the speed of many technological developments, it is sometimes difficult for people without a technological background to understand how these technologies work and what impact they may have. This book attempts to explain the latest technological developments with regard to drones in a straightforward manner. Similarly, experts in drone technology may not always be aware of the legal and ethical perspectives. As such, this book can be of value to academics in several disciplines, such as law, technology, ethics, sociology, politics, and public administration. Furthermore, this book may be of value to people who may be confronted with the use of drones in their work, such as those working in the military, law enforcement, disaster management and infrastructure management. Individuals and businesses with a specific interest in drones are also part of the target audience for this book.

1.1.2 The WODC Research Project

The idea for this volume on drones came from research that we carried out at the WODC, the research centre of the Ministry of Security and Justice in the Netherlands.[14] Both the Dutch parliament and the Dutch government requested

[14] http://www.wodc.nl. Accessed April 1, 2016.

this research in order to obtain more knowledge and information on the use of drones. This research was carried out in 2014 and published (in Dutch) in 2015.[15] The research approach was based on an extensive literature study, including scientific literature, professional literature and media messages with regard to the use of drones, and interviews, held with experts in various disciplines, including scientists who develop drones, companies that manufacture or use drones, companies that offer drone services and organizations that purchase such services, organizations in the security sector and scholars in the fields of privacy, ethics and human rights. In total, interviews were held with 17 individuals with the aid of a semi-structured questionnaire, complemented by conversations with about the same number of people of other organizations. The research report was submitted to the Dutch Minister of Security and Justice, who sent the research report to the Dutch Parliament indicating that he would come up with more detailed plans for the use of drones in the course of 2015. Some plans were presented and discussed in the Dutch Parliament on 21 September 2015, but during this debate it became clear that more detailed plans are needed in the coming years.

Apart from the research report mentioned above, researchers, policymakers and other experts in the field of drones and drone use were invited via a call for papers to submit chapters for this book. This was done via both a targeted approach, addressing authors of drone literature, and via posting and distributing the call for papers via websites and email. As a result, almost 30 abstracts were received, from which the authors of approximately 20 abstracts were invited to submit a full chapter. These chapters went through a double blind review process, after which some chapters were rejected or withdrawn. The call for papers opened in early 2015 and the final manuscript was ready end of 2015.

1.2 A Brief History of Drones

The recent media attention for drones suggests that civil drones are a new phenomenon and that such drones are a new technology. However, drones have existed for almost a century.[16] What is new, though, is the fact that today drones are small, relatively inexpensive and easily available. Drones sales figures are hard to find, but millions of drones have already been sold.[17] Amazon is selling more than 10,000 drones a month. In order to better understand where drone technology is heading, this section provides a brief history of drones.[18]

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[15] Custers et al. 2015.

[16] HSD 2014. Depending on definition, drones exist even longer. There are examples of aircraft without persons on-board during the American Civil War.

[17] Reagan 2015.

[18] For a detailed account of the historical development of drones, see also Villasensor 2013.

The earliest unmanned aircraft were probably (hot air) balloons. However, these balloons are generally not considered drones, mainly because their flight cannot be controlled.[19] During World War I, radio control techniques were used to build unmanned aircraft. The first flight of the Hewitt-Sperry Automatic Airplane was in 1917.[20] This airplane was developed as an aerial torpedo, for military purposes, and is considered to be a flying bomb and precursor of the cruise missile.[21] In 1918 was the first flight of the Kettering Bug, an unmanned aerial torpedo capable of striking ground targets in a range of 120 km, while flying at 80 km/h.[22] World War I ended before the Kettering Bug could be deployed. After World War I, airplanes were converted into drones. Examples are the Larynx (1927), the Fairy Queen (1931) and the DH.82B Queen Bee. The name Queen Bee is said to have led to the use of the term 'drone' (a male bee) for pilotless aircraft.[23]

During World War II, the Radioplane Company manufactured nearly 15,000 drones of the Radioplane OQ-2 for the US Army.[24] As such, it was the first mass-produced drone. This drone was launched with a catapult and recovered by parachute. The later version, the OQ-3 was also widely used during World War II, with over 9400 being built during the war.

After World War II, drones were also used for purposes other than being or dropping bombs. The first drone for aerial reconnaissance was the MQM-57 Falconer.[25] This drone had its first flight in 1955. It was a 124 kg aircraft that could carry cameras and illumination flares for night reconnaissance.[26] Over 73,000 were built and used in at least 18 countries.

During the Vietnam War, the US used Ryan Firebee drones,[27] which were developed in 1951. These drones were launched from Hercules transport aircraft, which could carry four Firebee drones in total, two attached under each wing. More than 7000 Firebees were built and, although production ended in 1982, some of them are still in service. For example, five (modernized) Firebees were used to lay chaff corridors (radar distraction with thin pieces of aluminum, metalized glass fibre or plastic) during the 2003 invasion of Iraq.

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[19] Note that from a legal perspective, balloons may be considered (unmanned) aircraft, see also Chap. 13.

[20] https://en.wikipedia.org/wiki/Hewitt-Sperry_Automatic_Airplane. Accessed 1 April 2016.

[21] Werrell and Stevens 1985.

[22] Zaloga 2008. See also https://en.wikipedia.org/wiki/Kettering_Bug. Accessed 1 April 2016.

[23] Yenne 2004. See also https://en.wikipedia.org/wiki/History_of_unmanned_aerial_vehicles. Accessed April 1, 2016.

[24] https://en.wikipedia.org/wiki/Radioplane_OQ-2. Accessed April 1, 2016.

[25] Anonymous 1956.

[26] https://en.wikipedia.org/wiki/Radioplane_BTT#MQM-57_Falconer. Accessed April 1, 2016.

[27] https://en.wikipedia.org/wiki/Ryan_Firebee. Accessed April 1, 2016.