TOWARDS BETTER REGULATION OF UNMANNED AERIAL VEHICLES IN NATIONAL AIRSPACE:

A COMPARATIVE ANALYSIS OF SELECTED NATIONAL REGULATIONS

by

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ABSTRACT

Historically, the unmanned aircraft has been an important component in military operations. The adaptation of unmanned aerial technology for civil purposes has rapidly captured the interest of the masses. Governments and hobbyists were the initial beneficiaries of the adaptation of Unmanned Aerial Vehicles (UAV) for civil use. With several industries such as agriculture, entertainment, real estate and delivery services using UAVs to perform essential functions, the proliferation of UAVs has become prominent in the commercial sector. The agile, affordable and accessible UAVs bring about many economic and social benefits. Nevertheless, the exponential growth of UAVs has also resulted in critical issues such as safety and privacy concerns. Due to the inherent differences between UAVs and manned aviation, the existing laws are inadequate to address the many issues that arise. Heeding to the rising problems, countries have resorted to strict and restrictive UAV regulations. UAVs are limited to segregated airspace and prevented from being fully integrated to a country's national airspace system. Strict regulations throttle innovation and discourage the nascent UAV industry. States are therefore burdened with demands to ensure aviation safety and uphold public rights to privacy on one hand, and demands to fully integrate UAVs to the national airspace on the other hand. The question is how national UAV regulations can address such a dichotomy. This thesis examines the development of national UAV regulations in selected countries and conducts a comparative analysis of the UAV regulations existing at the time of writing, to identify the best suited method to achieve regulatory balance. Upon the thesis findings it is recommended that sharing the regulatory responsibility between the government and the industry, increasing the involvement of the industry in drafting, implementing and enforcing regulations and thereby adopting the co-regulatory approach is the best way forward.

RÈSUMÈ

Historiquement, l'aéronef sans pilote a été un élément important dans les opérations militaires. L'adaptation de la technologie aérienne sans pilote à des fins civiles a rapidement éveillé l'intérêt des masses. Les gouvernements et les amateurs ont été les premiers bénéficiaires de l'adaptation des véhicules aériens sans pilote (UAV) à usage civil. Plusieurs industries telles que l'agriculture, le divertissement, l'immobilier et les services de livraison utilisent des UAVs pour remplir des fonctions critiques, ce qui a pour effet que la prolifération des UAVs est devenue prédominante dans le secteur commercial. Les drones agiles, abordables et accessibles apportent de nombreux avantages économiques et sociaux. Néanmoins, la croissance exponentielle des UAVs a également entraîné des problèmes critiques tels que la sûreté et la confidentialité. En raison des différences inhérentes entre les UAVs et l'aviation habitée, les lois existantes ne permettent pas de résoudre les nombreux problèmes qui surviennent. En tenant compte des problèmes croissants, les pays ont eu recours à des réglementations draconiennes strictes et restrictives. Les UAVs sont limités à un espace aérien séparé et ne peuvent être entièrement intégrés dans l'espace aérien national d'un pays. Les réglementations strictes étouffent l'innovation et découragent l'industrie naissante des UAVs. Les États ont donc le fardeau de maintenir la sécurité dans l'aviation et de protéger le public et leurs droits d'une part, et la demande d'intégration complète des drones afin que le plein potentiel de l'aviation sans pilote puisse être réalisé d'autre part. La question est de savoir comment les réglementations nationales sur les UAVs peuvent répondre à la dichotomie. La méthode la mieux adaptée pour atteindre l'équilibre requis est identifiée dans cette thèse en examinant l'élaboration de réglementations nationaux sur les UAVs et en procédant à une analyse comparative des réglementations actuelles sur les UAVs dans certains pays. Le partage de la responsabilité réglementaire entre le gouvernement et l'industrie, l'implication accrue de l'industrie des drones dans la rédaction, la mise en œuvre et l'application de la réglementation ainsi que l'adoption de l'approche de coréglementation constituent la meilleure voie à suivre.

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1. INTRODUCTION

"A man must rise above earth, to the top of the atmosphere and beyond – for only thus will he fully understand the world in which he lives"

– Socrates (469 – 399 BC)

Today, commercial aviation is an industry capable of making a global impact of USD 2.7 trillion, supporting 67.2 million jobs globally and connecting people, economies, cultures and countries.[1] Aviation has constantly evolved to align itself with market demands, technological advancements, sustainable development goals and the greater good of humanity. The next step for aviation is indisputably commercial unmanned aviation. With the exponential growth of various applications and the number of users, Unmanned Aerial Vehicles (UAV) or as popularly known drones, are set to become ubiquitous in a future not too distant. .

UAVs currently offer a range of commercial applications such as aerial photography and videography, data collection by remote sensing, small package delivery and insurance investigations. Plans are already in place for expanded delivery of goods[2] and passenger transport.[3] The projected, global market growth of the UAV industry by the year 2020, is valued at USD 1.8 billion.[4] The economic potential alone of this budding industry is impressive.

For a country to fully realize the benefits of commercial UAVs, integration of UAVs to the national air space is necessary. Unfortunately, the integration has not been completed in any State as of now. The primary reason for the delay is the lack of laws and regulations facilitating such integration. The existing aviation laws and regulations are premised upon the concept of a pilot onboard limited by several physical and technical boundaries. Hence the direct application of existing regulations to UAVs would not be adequate, nor fit to address all

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[1] IATA, "Fact Sheet on Economic & Social Benefits of Air Transport" online: <www.iata.org/pressroom/facts_figures/fact_sheets/Documents>.
[2] "Amazon Prime Air" online: Amazon <www.amazon.com/Amazon-Prime-Air/>.
[3] Christopher Jasper "Flying Taxis, Killer Drones and Five More Paris Air Show Highlights" *Bloomberg* (23 June 2017) online: <www.bloomberg.com>.
[4] *Commercial Drones: A Global Strategic Business Report* (San Hose: Global Industry Analysts, 2016).

facets of unmanned aviation. Appreciating the stark differences between manned and unmanned aviation, certain States have already taken steps to issue new UAV specific regulations, guidelines and other advisory material. However, s this thesis argues that, fueled by the negativity surrounding UAVs in the society due to numerous reported incidents including collisions with people, property and aircraft, illegal trespassing, breach of privacy and national security concerns; regulations introduced by States are strict, restrictive and curbs industry potential. The rigidity of the regulations has excruciatingly prolonged the process of integrating UAVs to the national air space and imposes unnecessary costs and complex administrative requirements upon an upcoming industry. What is actually needed is, a set of regulations ensuring safety whilst encouraging the growth of the UAV industry. It is irrational and unwise to keep clinging to a set of prohibitive rules which would only lead to stifling innovation.

The regulations should evolve to achieve full integration of UAVs to national airspace. This thesis, employing the doctrinal research method, maps the development of UAV regulations in four selected jurisdictions and then conducts a comparative analysis of the regulations in order to identify the best way forward.

Chapter 2 examines the background and history of UAVs and maps the transformation of UAVs from an exclusive military utility to the commodity it is today. The chapter provides a concise discussion as to the numerous applications of UAV technology, its benefits to mankind and ends with emphasizing the need for regulation.

Chapter 3 discusses the several problems caused by the exponential growth of UAVs. The aim of the chapter is to examine the scope of the problems which are commonly identified as the main deterrents to States introducing permissive regulations. The problems are discussed in reference to the legislative and regulatory efforts of selected countries taken in order to mitigate the risks, the rigidity of the said regulations and its effect upon the industry.

Chapter 4 takes a deeper look in the UAV regulations introduced in response to the rising concerns. Given the limitations as to the length and scope of the thesis, the chapter is confined to examining the regulations of Australia, Canada, United States and the European Union. The said jurisdictions were chosen as they represent relatively well-developed UAV regulations, the ease of access to legislative and administrative documents, and readily available industry facts. Chapter 4 identifies the evolving nature of UAV regulations and how States are gradually removing the red tape. But yet, the regulations are not adequately permissive for commercial UAV operations to take flight.

The 5th and final chapter presents a comparative analysis of the regulations discussed in Chapter 4. It discerns that many common traits are present in every regulatory framework and identifies unique features making an impact upon the industry. By way of a comparative analysis of the regulations, Chapter 5 reaches the conclusion that if UAV regulations are to achieve the perfect balance between ensuring safety and promoting the industry, co-regulation or the sharing of the regulatory role between the government and the industry, is the best way forward. By involving the industry in the process of making regulations for UAVs, one can expect a higher level of compliance and efficient monitoring of the rapidly expanding numbers of commercial UAV users.

The UAVs could well be the defining feature of the 21st century. Hence the goal should be not to thwart its development by regulation, but to use regulation to encourage the industry, innovative technologies and establish a well-respected UAV safety culture. It is intended that this thesis will present a guideline to law makers, regulators and the other stakeholders on how to reach the perfect synergy between regulation and industry growth.

2. THE DAWN OF THE DRONE AGE

2.1 Introduction

Unmanned aviation has a long history preceding manned aviation.[5] The rapid technological and industrial development in manned aviation solidified its position as an integral part of day to day life, whereas unmanned aviation was more or less confined to military milieu. However, in the recent decade, the status of unmanned aviation has changed drastically. The adaptation of UAVs for civil and commercial purposes, and the use of UAVs for day to day chores, has propelled the interest of governments, private companies, and the public alike.

UAVs are a disruptive technology. Unlike manned aviation, they are easily accessible, affordable, and allow anonymity. Similar to many novel technologies such as smart phones, "[the] development of unmanned aerial technology has soared while costs have constantly reduced."[6] With the growth of UAVs the airspace has become increasingly democratized.[7] Complete integration of UAVs to the non-segregated airspace is inevitable and would present a various opportunities for expanded commercial UAV operations.[8] But, one must not forget the many ethical, social and legal issues, intertwined with the proliferation of UAVs and the need to facilitate a safe UAV culture.

[5] Ron Bartsch, James Coyne & Katherine Gray, *Drones in Society: Exploring the strange new world of unmanned aircraft* (London: Routledge, 2017); Lawrence R. Newcome, *Unmanned Aviation: A Brief History of Unmanned Aerial Vehicles* (Virginia: AIAA, 2004).

[6] Bartsch, Coyne & Gray, *supra* note 5 at 8.

[7] Douglas M. Marshall et al. eds, 2nd ed., *Introduction to Unmanned Aircraft Systems* (Boca Raton: Taylor & Francis, CRC Press, 2006) at 316.

[8] IATA, "Drones: A new player on aviation's radar" (21 August 2017) online: IATA <airlines.iata.org/analysis/constructive-technology>.

2.2 Differences in the terminology

The terminology surrounding UAVs is diverse and vibrant. In the early stages, UAVs were identified terms such as, 'flying bombs', 'guided missiles',[9] or 'aircraft without a pilot[10]. Today, an array of aircraft specific terms is used to identify unmanned aircraft. "The most common and well known is the onomatopoeic term "drone",[11] which was connoted as homage to the 'Queen Bee', an early military unmanned aircraft programme.[12] However, the continued public negativity and the stigma associated with military drones engaged in armed operations incited the use of alternative terms to promote the adaptation of UAVs for domestic purposes.

The term Unmanned Aerial Vehicle (UAV) came into prominence in the early 1990's.[13] The United States (US) Department of Defense defines a UAV as "a powered, aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide vehicle lift"[14] which can be flown autonomously or be piloted remotely.[15] Canada adopts a similar definition for UAVs being, "power driven aircraft, other than a model aircraft, that is designed to fly without a human operator on board."[16] A noticeable fact is that the term UAV elucidates both remotely piloted and autonomous aircraft. When analysing different UAV specific national regulations, it was observed that governments have opted for the terminology in a manner that shape the regulatory framework. UAV, Unmanned Aircraft Systems (UAS), Remotely Piloted Aircraft (RPA) and Remote Piloted Aircraft Systems (RPAS) are common.

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[9] Newcome, *supra* note 5; Marshall, *supra* note 7.
[10] Convention Relating to the Regulation of Aerial Navigation (as modified by protocol 1929, signed 13 October 1919, art.15 (2) [*Paris Convention 1919*]; Convention on International Civil Aviation, signed of 7 December 1944, art. 8. [*Chicago Convention 1944*].
[11] Benjamyn I. Scott ed., *The Law of Unmanned Aircraft Systems: An Introduction to the Current and Future Regulation under national, Regional and International Law* (UK: Kluwer Law International,2016).
[12] Bartsch, Coyne & Gray, *supra* note 5 at 25.
[13] Newcome, *supra* note 5, ch. 1.
[14] US DOD, *DOD Dictionary of Military and Associated Terms*, JP1-02 (30 November 2004) online: DOD < www.dtic.mil/doctrine/jel/doddict/data/u/05601.html >.
[15] *Ibid.*
[16] *Canadian Aviation Regulations*, SOR/96-433, s. 101.01(1).

The US, a key player in the commercial UAV industry adopted the term UAS early on, as depicted in its 2013 Roadmap for integration.[17] The purpose of using the term UAS was "to emphasize the fact that separate system components are required to support airborne operations without a pilot onboard the aircraft."[18] The term UAS perfectly encapsulates the unmanned aircraft, control station and the data link, whilst the term UAV is confined to the aircraft.[19] A clear example as to the US application of the term UAS is the recently published final rule on small UAS which adopts the following definition for small UAS. The definition is a succinct indication to the scope and ambit of the rule:

> Small unmanned aircraft system (small UAS) means a small unmanned aircraft and its associated elements (including communication links and the components that control the small unmanned aircraft) that are required for the safe and efficient operation of the small unmanned aircraft in the national airspace system.[20]

As further demonstrated by the approach of the Civil Aviation Authority (CAA) of the United Kingdom,[21] governments are likely to opt for the term UAS as it paves way for comprehensive regulations covering both the unmanned aircraft and ancillary components needed for its operations. [22] Transport Canada acknowledges the use of the term drone in general when "referring to any type of unmanned aircraft system."[23] However, in Canada's proposed new regulations the term UAS is used to "align with international regulatory

[17] US DOT, FAA, 1st ed., *Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap* (Washington, DC: US FAA, 2013). ("[T]he term UAS is used to emphasize the fact that separate system components are required to support airborne operations without a pilot onboard the aircraft.")
[18] *Ibid.*
[19] Jordan M. Cash, "Droning on and on: A tort approach to regulating hobbyist drones" (2016) 46 U Mem L Rev, 696.
[20] 14 CFR §107.3.
[21] UK, CAA, "An Introduction to the Unmanned Aircraft Systems", online: CAA <www.caa.co.uk>.
[22] Stefan A. Kaiser, "UAVs and Their Integration into Non-segregated Airspace" (2011) 36:2 Air & Space L 161-172.
[23] Transport Canada, "Proposed Rules for drones in Canada" online: <www.tc.gc.ca>.

authorities."[24] The term UAS is wide enough to encompass both remotely piloted and autonomous unmanned aircraft and affords more leeway for aviation authorities to introduce regulations. Hence in the long-run, the term UAS could become a popular option for many governments.

Australia, one of the first countries to introduce a specific set of regulations for UAVs, replaced the term UAV with the term RPA on 30th March 2016, by an amendment to its *Civil Aviation Safety Regulations 1998* (CASR).[25] Australian regulations extend to Remotely Piloted Aircraft Systems (RPAS) which includes the aircraft and all ancillary elements such as the ground control stations.[26] The change of terminology was in order to align the Australian regulations with that of the International Civil Aviation Organization (ICAO).[27]

The ICAO, addressing the issue of unmanned aviation in its Global Air Traffic Management Operational Concept of 2005 used the term UAV to denote the unmanned aircraft. ICAO defined the term as;

> a pilotless aircraft, in the sense of Article 8 of the Convention on International Civil Aviation, which is flown without a pilot-in-command on-board and is either remotely and fully controlled from another place (ground, another aircraft, space) or programmed and fully autonomous.[28]

In 2007, the ICAO took upon itself to lead research for UAV regulations with the establishment of the Unmanned Aircraft Systems Study Group (UASSG)[29] and the work of the UASSG was in the perspective of the "aircraft and its associated elements which are operated

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[24] *Ibid.*
[25] *Civil Aviation Safety Regulations 1998* (Cth) part 101. (Defining the term Remotely Piloted Aircraft (RPA) to be an unmanned aircraft, other than a balloon or kite, where the pilot flying is not on board the aircraft.)
[26] *Ibid*. (Remotely Piloted Aircraft System (RPAS) is a set of configurable elements consisting of a remotely piloted aircraft, its associated remote pilot station(s), the required command and control transmitters and receivers, and any other system elements as may be required at any point during flight operation.)
[27] Bartsch, Coyne & Gray, *supra* note 5.
[28] ICAO, *Global Air Traffic Management Operational Concept*, Doc 9854 / AN 458, (2005).
[29] The UASSG was decided to be established at the 175th Session of the ANC in 2007.

with no pilot on board".[30] Later in 2014, the Remotely Piloted Aircraft Systems Panel (RPASP) was formed superseding the UASSG.[31] The RPAS published the Manual on Remotely Piloted Aircraft Systems,[32] which refers to remotely piloted aircraft, based upon the conclusion that "only unmanned aircraft that are remotely piloted could be integrated alongside manned aircraft in non-segregated airspace and at aerodromes."[33] The ICAO has thereby distinguished between remotely piloted aircraft and autonomous aircraft, leading to drastically narrow down its regulatory scope over unmanned aviation.[34]

Following ICAO's lead, many countries have opted to continue the use of the term RPAS. The issue in using the term RPAS in a national regulatory framework is whether it effectively shut out the operation of fully autonomous unmanned aircraft in airspace? Although fully autonomous UAVs are currently in experimental stages, the technology is rapidly developing. (Especially, the technology required to enable an unmanned aircraft act and respond in real-time and comply with instrument flight rules and visual flight rules). It is already reported that the Israeli Civil Aviation Authority has authorized fully automated UAVs to carry out Beyond Visual Line of Sight (BVLOS) commercial operations.[35] Hence, the adoption of fully autonomous UAVs for commercial purposes may not be rhetoric for too long. ICAO as the international governing body for civil aviation, is thus urged to reconsider its stance on limiting itself to remotely piloted unmanned aircraft.

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[30] ICAO, *Unmanned Aircraft Systems (UAS) Circular*, CIR 328, AN/190 (Montreal: ICAO, 2011).
[31] ICAO, NAM CAR Regional Officer, *Presentation on Remotely Piloted Aircraft Systems (RPAS)* (Mexico, April 2016). Online: ICAL <www.icao.int/>.
[32] ICAO, *Manual on Remotely Piloted Aircraft Systems (RPAS)*, Doc 10019 AN/507, (2015).
[33] *Ibid.*
[34] US, NASA, "Perspectives on Unmanned Aircraft classification for airworthiness standards", NASA/TM–2013-217969 online: <shemesh.larc.nasa.gov>.
[35] Caroline Rees, "Airobotics Approved to Fly Fully: Automated BVLOS Drones" (31 March 2017) *Unmanned Systems News* online: <www.unmannedsystemstechnology.com>; Reuters "Fully- Automated Drone has Israeli firm reaching for the sky" (24 March 2017) *The Jerusalem Post*, online: </www.jpost.com>.

2.3 History and evolution of unmanned aviation

Despite the recent spike in commercial interest in UAVs, unmanned aviation has long existed.[36] Often assigned to carry out the "dirty, dull and dangerous"[37] acts unmanned aircraft were historically important components of military endeavours. The first recorded use of unmanned aviation is when Austrians attempted to bombard Venice by flying unmanned balloons loaded with explosives over the city in 1849.[38]

The foundation for the current technology in unmanned vehicles was laid in 1898 with the introduction of a tele-automated boat by the inventor, Nikola Tesla.[39] With the dawn of 1900's and the beginning of World War I (WW I), the concept of unmanned vehicles for warfare was much favoured.[40] Following which the Hewitt – Sperry automatic airplane was invented in 1917. The Hewitt- Sperry airplane was capable of being remotely steered and had automatic stabilizers.[41] It is often referred to as the first modern unmanned aircraft.[42]

The military prowess of UAVs continued to develop after WW I and several aircraft were repurposed as remote controlled, pilotless aircraft to be used as targets or guided missiles.[43] The DH.82 Queen Bee aircraft operated by the British army, (a classified project at that time) completed its first remotely piloted flight in 1935 marking a significant advancement

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[36] Donna A. Dulo, ed, *Unmanned Aircraft In The National Airspace: Critical Issues, Technology and the Law* (Chicago: ABA, 2015); Konstantinos Dalamagkidis, K. Valavanis, & Les A. Piegl, *On Integrating Unmanned Aircraft Systems into the National Airspace System: Issues, Challenges, Operational Restrictions, Certification, and Recommendations* (Netherlands: Spinger, 2012).

[37] Marshall *supra* note 7; Dulo *supra* note 36.

[38] Viennese newspaper *Die Presse;*

> "Venice is to be bombarded by balloons, as the lagunes prevent the approaching of artillery. Five balloons, each twenty-three feet in diameter, are in construction at Treviso. In a favorable wind the balloons will be launched and directed as near to Venice as possible, and on their being brought to vertical positions over the town, they will be fired by electro magnetism by means of a long-isolated copper wire with a large galvanic battery placed on a building. The bomb falls perpendicularly, and explodes on reaching the ground." cited in Vintage Wings of Canada, "The Mother of All Drones" online: <www.vintagewings.ca>.

[39] Konstantinos Dalamagkidis, "Aviation History and Unmanned Flight" in Kimon P. Valavanis & George J. Vachtsevanos, eds., *Handbook of Unmanned Aerial Vehicles* (Springer, 2015) at 57.

[40] Dulo, *supra* note 36; Marshall *supra* note 7.

[41] Newcome, *supra* note 5.

[42] Bartsch, Coyne & Gray *supra* note 5 at 23.

[43] *Ibid* at 24.

in the technology. DH.82 Queen Bee was the first remotely piloted, "multiuse unmanned aircraft, [with the ability] to fly over 17,000 ft at a speed over 160 kph."[44] In the late 1930's, the Hollywood actor Reginald Denny's development of the Radioplane, made an important addition to the development of unmanned aviation. With the modification of a Radioplane (RP-17) model by adding film cameras, Denny's company became responsible for the world's first reconnaissance UAV.[45] Denny was also an advocate of the commercial viability of UAVs. As reported by The American Magazine of 1947, Denny was promoting for the commercial use of his "midget radio plane," emphasizing its potential in crop-dusting and fighting forest fires.[46]

Given the military advantages of UAVs or drones (as referred in the military context); World War II (WW II) spurred its development in both the United States and Europe.[47] The post-WW II period and the advent of the Cold War propelled the use of drones for reconnaissance and surveillance purposes.[48] The invention of the inertial navigation systems (INS) for aircraft by Charles Draper in the 1950's eliminated the need for dependence on external input and enabled robotic flight to navigate with precision.[49] With such advanced developments of unmanned aerial technology, the subsequent Vietnam War (1955 – 1975) marked the "coming of age" for drones.[50] The US unmanned aerial vehicles programme - the 'Lightening Bugs', is often identified as the most sophisticated programme of drone surveillance in the history of flight," and was the precursor for today's drone warfare.[51] Israel,

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[44] *Ibid* at 25.
[45] Newcome, *supra* note 5 at 59.
[46] CITIE, "The Radioplane Target Drone" online: Monash.edu, <www.ctie.monash.edu.au/hargrave/rpav_radioplane4.html>.
[47] Newcome, *supra* note 5.
[48] See *ibid;* Steven J. Zaloga, *Unmanned Aerial Vehicles: Robotic Air Warfare 1917 – 2007* (Osprey Publishing, 2008).
[49] Newcome, *supra* note 5 at 79.
[50] Newcome, *supra* note 5 at 80; Ian G. R. Shaw, "Scorched Atmospheres: The violent geographies of the Vietnam War and the rise of drone warfare" (2016) 106:3, Ann AA Geographers, 688 – 704.
[51] Shaw *supra* note 50.

in the Yom Kippur War (1973), used the drones (the Firebee) bought from the US, to counter anti-aircraft missiles from Egypt, leading to an era of lethal drone attacks.[52]

The subsequent Israel – Lebanon War (1982), the Gulf War (1990 – 1991), wars in Afghanistan (2011), Iraq (2013) have added to the legacy of war faring by drones. Despite the severe criticisms against target killings and continued reconnaissance operations, drones remain integral to military strategy. By 2013, the US alone is said to have operated approximately 7500 drones ranging from small lightweight surveillance models to larger models such as the Predator or Reaper.[53] Presently it is estimated that over 90 States and non-state actors operate drones in a military context.[54]

Although initiated as a military tool, the unmanned aircraft have proven capable of being "domesticated."[55] As seen throughout the past decade, drones have transitioned from the role of a lethal weapon to an essential farming tool, efficient delivery method, an aerial photographer and in most cases, a toy. A key feature of the transformation process is the increased dissociation from the term "drone" and the adaptation of alternative terms discussed before.

The adaptation of unmanned aerial technology for commercial and other activities has been rapid and innovative. In 2002 the total number of UAVs was estimated at 2400, and 66% were operated for commercial purposes.[56] The numbers have continued to grow and by the end of 2016, over 1.1 million units of UAS (42,000 units for commercial purposes) were registered only within the US.[57] UAVs are now identified as "powerful business tools."[58] In the words of

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[52] *Ibid.*
[53]Michael J. Boyle, *The Race for Drones* (Foreign Policy Research Institute, 2015) online: FPRI <www.files.ethz.ch/isn/187861/boyle_on_drones.pdf>.
[54]Kelley Seyler, *A World of Proliferated Drones: A Technology Primer* (Center for New American Security, 2015) online: CNAS <drones.cnas.org/>.
[55] Henry H. Perritt Jr & Eliot O. Sprague *Domesticating Drones: The Technology, Law, and Economics of Unmanned Aircraft* (London; Routledge, 2017).
[56] Newcome, *supra* note 5 at 130.
[57] US FAA, "Aerospace Forecast 2017" online: FAA <www.faa.gov>.
[58] Goldman Sachs, *Drones Reporting for Work* (2016) cited in Tom Standage, "Taking flight: Commercial drones are the fastest-growing part of the market" (10 June 2017) *The Economist*, online:<www.economist.com>.

the Brendan Schulman, the Head of Policy at Da-Jiang Innovations (DJI), the company holding over 70% market share in the global UAV market,[59] UAVs are no longer mere "military products that were downsized- [but] consumer technologies that got better."[60]

2.4 Applications of Unmanned Aerial Vehicles

The adaptation of unmanned aerial technology to civil and commercial purposes has resulted in a multitude of UAV applications, currently used by governments, private companies and individuals. UAVs are used for education and experiments, for recreation and leisure, public purposes by governments and for commercial ventures. Law enforcement agencies employ UAVs for accident investigations, border patrol, pursuit of criminals and surveillance.[61] UAVs are utilized in search and rescue missions,[62] emergency response and disaster management[63] such as fire, floods and earthquake situations where UAVs are deployed beforehand to gain situational awareness.[64]

The uses of recreational UAVs vary from taking 'selfies',[65] to competitive drone racing.[66] In the US alone, by 2020 the sale small UAVs for recreation is predicted to reach 4.3 million. [67] Despite the ongoing controversies regarding the use of small UAVs for indecent and illegal purposes in the guise of recreation, the hobbyist UAV business is flourishing by the day.

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[59] *Ibid.*
[60] *Ibid.*
[61] See e.g. Chris Aadland, "Madison Police are now in the air, thanks to two new drones" *Wisconsin State Journal* (25 July 2017) online: <host.madison.com>; Nick Squires, "Police use drones and dogs to stop migrants crossing border on Riviera between Italy and France" *The Telegraph* (30 June 2017) online:< www.telegraph.co.uk>; Spencer Ackerman 'US Drones are now sniffing Mexican Drugs" *The Wired* (16 March 2011) online: <www.wired.com>.
[62] See e.g. "Drones rescue trapped people in Grand Canyon" *Deccan Chronicle* (22 April 2017) online: <www.deccanchronicle.com>; Carson Gerber "New search and rescue drone stationed in local DNR district" *Kokomo Tribune* (23 November 2016) <www.kokomotribune.com>.
[63] Heather Kelly, "Drones: The future of disaster response" *CNN* (23 May 2013) online: <www.cnn.com>; Stuart M. Adams & Carol J. Friedland "A Survey of Unmanned Aerial Vehicle (UAV) Usage for Imagery Collection In Disaster Research And Management" (2011) online: <semanticscholar.org>.
[64] "Illinois firefighters use drones at house fire", *Fire Engineering* (30 August 2015) online: <www.fireengineering.com>
[65] See DJI, "Wow your friends with your cool drone selfies" online: <https://store.dji.com/>.
[66] See, International Drone Racers Association online: <http://www.idra.co/>.
[67] FAA, *Aerospace Forecast Report Fiscal Years 2016 – 2036* (2017).

The numerous functions of UAVs in commercial use include aerial mapping and surveying,[68] precision agriculture, resource management, industrial inspection, aerial filming and photography, atmospheric data collection, [69] water sampling, crop dusting and cargo delivery.[70]

The agriculture industry is a prominent user of UAVs. Using UAVs to replace manned aircraft in inherently dangerous, agricultural activities such as the aerial application of chemicals can be traced to the early 1980's. [71] UAVs are used for precision agriculture[72] where the advanced sensing capabilities of UAVs allow successful crop health and damage assessments, visual captures of irrigation problems, soil variations and fungal infections on plants.[73] The agricultural industry has derived many benefits from the continued use of unmanned aerial technology. It has helped increase production efficiency, minimize costs,[74] and supplement the waning work force in fields. In 2013, the Association for Unmanned Vehicle Systems International (AUVSI) report indicated that agriculture was expected to be the largest market application for UAVs.[75] Also, a recent study forecasts USD 4,209.2 million market value for agricultural UAVs by 2022.[76]

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[68] Marshall *supra* note 7.
[69] Jonathan Vanian "Nasa is flying a huge drone over hurricane Matthew" *Fortune* (8 October 2016) online: <fortune.com/2016/10/07/nasa-drone-hurricane-matthew/>.
[70] Marshall, *supra* note 7 at 24-40.
[71] Kana Inagki , "Yamaha aims to unlock US and EU markets with agricultural drone" *Financial Times* (5 July 2015) online:< www.ft.com>.
[72] Precision agriculture is a farm management system that utilizes information and technology to enhance production of the farm. See e.g. Chris Anderson, "Agricultural Drones: Relatively cheap drones with advanced sensors and imaging capabilities are giving farmers new ways to increase yield and reduce crop damage" *MIT Technological Review* online: <www.technologyreview.com>; Agmapsonline "Unmanned Aerial Vehicles (UAV) in Precision Agriculture" (6 January 2014) online: <agmapsonline.com/2014/01/06/unmanned-aerial-vehicles-uav-in-precision-agriculture/>.

[73] *Ibid*; South Africa, ENCA, "Drones give new perspective in farming" (19 July 2017) online: <www.enca.com>.
[74] Marshall, *supra* note 7 at 26.
[75] *Ibid* at 27.
[76] Marketsandmarkets, *Report on Agriculture Drones Market by Type (Fixed Wing, Rotary Blade, Hybrid, Data Analytics Software, Imaging Software), Application (Field Mapping, VRA, Crop Scouting, Livestock, Crop Spraying), Component and Geography - Global Forecast to 2022* (June 2016) online: <www.marketsandmarkets.com>.

Aerial photography and videography capabilities of UAVs are heavily utilized in the entertainment industry, advertising and journalism. Within a short period, the role of UAVs in the entertainment industry became essential that it is one of the first commercial ventures to receive an exemption under section 333 of the *FAA Modernization and Reform Act of 2012* in the US.[77]

UAVs are useful in conducting industrial inspections. small Vertical Take-off and Landing (VTOL) UAVs [78] are often used to carry out inspections as to the conditions of bridges, roads and dams,[79] to monitor the structural integrity of transmission poles, transformers, and insulators, thermal infrared power line surveys, oil and gas exploration, patrol oil pipelines and flare stack inspection, [80] weather monitoring and environmental monitoring.[81]

UAVs play a crucial role in the energy sector, by replacing workers engaged in dangerous activities such as climbing pylons and cooling towers, to inspect infrastructure. Within the years 2017 to 2025, the global demand for UAVs in the energy sector is expected to reach a market value of USD 4.47 Billion.[82] In addition to monitoring infrastructure, gathering and real-time relay of necessary data for maintenance purposes, UAVs are used to further renewable energy goals. Experiments are already underway to use UAVs to tap into the energy of high altitude wind currents. It is estimated that airborne wind energy production by UAVs would halve the cost of offshore wind energy.

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[77] Jack Nicas "FAA Clears six film companies to use drones: Decision marks first exemption of their kind from ban on commercial drone use" *The Wall Street Journal* (25 September 2014) online: <www.wsj.com>; Richard Verrier, "FAA gives drone exemption to Hollywood production firms" *Los Angeles Times* (25 September 2014) online: <www.latimes.com>.
[78] Examples include the Aerovel Flexrotor, DJI Inspire, Aeryon SkyRanger where most do not require runways to take-off or land nor any type of equipment such as catapults or nets for the launch and recovery (L & R).
[79] Marshall *supra* note 7 at 3.
[80] Rebecca Smith, "Utilities turn to drones to inspect power lines and pipelines", *The Wall Street Journal* (5 May 2015) online: <www.wsj.com>.
[81] Darryl Jenkins & Dr. Bijan Vasigh, *Report on The Economic Impact of Unmanned Aircraft Systems Integration in The United States 2013* (AUVSI, 2013).
[82] Research and Markets, *Report on Drones for Energy Industry: Global Market Research, Forecast, and Strategy 2016-2025* (2016), online: <www.researchandmarkets.com>.

UAVs are used in journalism, land surveying, advertising and insurance claims investigations and risk assessments.[83] The transportation industry is faced with major changes with the advent of UAVs. Use of UAVs could potentially replace deliverymen, trucks, bicycles and other vehicles to carry out rapid and customized delivery services. A prime example is the announcement made by Amazon.com Inc., of its plans to carry out package delivery using UAVs. [84] In furthering its plan, Amazon Prime Air has successfully completed its first air delivery[85] and in the attempt to create the necessary infrastructure for its delivery UAVs - filed patent applications for "beehive" structured store to recharge and house small UAVs.[86] Following Amazon on delivery UAVs, are companies such as DHL, Google and Walmart. DHL going a step further has concluded mail delivery trials in Reit im Winkl, Germany by directly integrating its Parcelcopter UAV logistically into its delivery chain, combined with automated loading and offloading at 'packstations.'[87] The "world's first operational UAV delivery service" was launched in Reykjavik, Iceland, by the Israeli company Firetrex for food delivery.[88] The recent announcement made by Airbus of its collaboration with Singapore Post for the Skyways parcel delivery project, an experimental project for seamless parcel deliveries by UAVs in urban cities.[89] In early 2017, The Roads and Transport Authority in Dubai released

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[83] Perritt & Sprague *supra* note 55 at 22.

[84] "Amazon unveils futuristic plan: delivery by drone" *CBS News*, (1 December 2013) online: <www.cbsnews.com>.

[85] Alex Hern, "Amazon claims first successful Prime Air drone delivery" *The Guardian* (14 December 2016) online: <www.theguardian.com>.

[86]Mattew Field, "Amazon patents nine storey beehives to use as drone delivery centres" *The Telegraph* (23 June 2017) online: <www.telegraph.co.uk>.

[87]DHL, Press Release "Successful trial integration of DHL Parcelcopter into logistics chain" (05 September 2016) online: <www.dhl.com/en/press/releases/releases_2016>.

[88] Karen Gilchrist, "Wórld's first drone delivery service launches in Iceland" *CNBC* (23 August 2017) online: < www.cnbc.com>; Thomas Macaulay, "How Flytrex launched the world's first urban autonomous drone delivery system" *Techworld* (4 September 2017) online: <www.techworld.com>; Steve Banker, "Iceland Gets a drone delivery service, alight version of Jeff Bezos' bold vision" *Forbes* (23 August 2017) online: < www.forbes.com>;

[89] Airbus, Press Release "Airbus Helicopters selects SingPost as Skyways logistics partner" (18 April 2017) online: < /www.airbushelicopters.asia>.

footage of a UAV able to carry passengers and unveiled the Dubai government's plan to initiate a human-ferrying service by autonomous UAVs.[90]

The numerous projects reported to be in the test phase further reveal the opportunities afforded by civil and commercial application of UAVs. For example, Facebook plans to provide worldwide wireless internet via high altitude, solar powered UAVs,[91] Microsoft in its Project Premonition aims to use UAVs for identifying disease spreading mosquitos,[92] McGill University School of Computer Science's hand-sized UAV is capable of using the artistic technique of stippling to create paintings, which can be used for outdoor murals[93] and prototypes exist for lifeguard UAVs to deliver float-assistants to drowning victims and ambulance UAVs for medical emergencies.[94]

The continuing experiments in robotics, digitization and machine learning heavily contribute to the advancements of unmanned aviation. The use of UAVs for various civil and commercial purposes is gradually becoming a common and a normal aspect in our day-to-day lives.

2.5 The economic impact

The impact of UAVs in both economic and social contexts is vast and should be given due consideration when laws and regulations are being drafted. In an economic viewpoint the impact is mostly positive. The "increased agility, shorter development cycles and frequent

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[90] Jon Gambrell, "Up up and away: Passenger carrying drone to fly in Dubai" *AP News* (13 February 2017) online: <apnews.com/d53625cc57124bf992e934522d4c1d6e/and-away-passenger-carrying-drone-fly-dubai≥; Steven Overly, "A drone carrying humans prepare to take flight in Dubai" *The Washington Post* (15 February 2017) online: <www.washingtonpost.com>; Sphie Morlin-Yron, " Driverless flying taxi services to launch in Dubai" *CNN* (17 March 2017) online: <www.cnn.com>.

[91] Video: Facebook Closer to provide internet, *The Independent* online: <http://www.independent.co.uk/>; "Facebook drone that could bring global internet access completed test fight" (2 July 2017) *The Guardian* online: < www.theguardian.com>.

[92] Allison Linn, "Project Premonition" (blog: Microsoft) online: < blogs.microsoft.com/>.

[93] McGill University, "Dot drawing with Drones" (News, 4 August 2016) online: <https://www.mcgill.ca/newsroom/channels/news/dot-drawing-drones-261928>.

[94] See Robert J. Sczbercz "The Future of HealthTech – Ambulance Drones" (14 December 2014) *The Forbes* online: <www.forbes.com>.

technology updates in commercial UAVs …offer [enhanced] economic viability, reliability and support" to its users.[95] The UAV economies of scale has resulted in a sharp decrease of cost, and therefore the once sophisticated and unattainable UAVs are now in abundance, available for anyone and affordable.[96]

In 2015, the Teal Group's market study predicted that the global UAV industry valued at USD 4 billion at the time, will rise to USD14 billion by 2025.[97] The numerous UAV applications create new business opportunities and has potential to substantially alter the conventional methods of business operations to "unlock new revenue generation and cost optimization opportunities."[98] As demonstrated above, many industries already employ UAVs. The 2016 PwC global report estimates the total addressable market for UAV based applications in all industries at USD 127 billion.[99]

The infrastructure industry has the best prospects with an addressable market value of over USD 45 billion[100] followed by agriculture, transport, security, media and entertainment, insurance and telecommunication. Compared to manned aviation and human labour, UAVs are cheaper, faster and an easy workforce to direct and control. UAVs are fuel efficient, eco-friendly and adaptable than conventional vehicles.[101] Exploitation of UAVs by a profit-oriented company, allows more benefit at a lesser cost.[102]

The impact of UAVs upon the economy is well demonstrated by the predictions made in 2013, by the Association of Unmanned Vehicle Systems International (AUVSI). According

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[95] *Ibid*.
[96] Trevir Nath, "How Drones are Changing the Business World", *Investopedia* (Online: <www.investopedia.com>.
[97] Teal Group, Press Release, "UAV Production will total $93 billion" (19 August 2015) online: <tealgroup.com/index.php/teal-group-news>.
[98] Michal Mazur et. al, *Clarity from Above: PwC global report on the commercial applications of drone technology* (PwC, May 2016) at 15.
[99] *Ibid.*
[100] *Ibid.*
[101] See generally Enrique Moguel et al., "Towards the Use of Unmanned Aerial Systems for Providing Sustainable Services in smart Cities" (2018) 18:1 Sensors 64; Robert Wolf & Brandon Torres Declet, "The aerial data revolution is approaching" *Business Insider (8 February 2016)* online: <www.businessinsider.com>.
[102] *Supra* note 98.

to the AUVSI report, within the first three years of integrating UAS to the US national air space, over 100,000 jobs would be generated and the total impact upon the US economy was predicted to be USD 13.6 billion.[103] As discernible from the AUVSI report, the key to reap economic benefits of UAVs is integration to the national air space and "every year …integration is delayed, the United States loses more than USD 10 billion in potential economic impact."[104]

Despite the lack of comprehensive regulations facilitating the full integration of UAS to the US national air space, the growth of UAVs has not diminished. The progress of UAVs within the US was recognized by the FAA, in its 2016 Aerospace Forecast, which predicted 2.7 million commercial (non-model aircraft) small UAS units in the US air space by 2020 and concluded that commercial UAVs are the most dynamic growth sector within aviation.[105]

Europe, a forerunner in the UAV market, estimates that sales in both commercial and government owned UAVs to reach EUR 2 billion by 2030.[106] The value-added services including maintenance, repairs, training of pilots, software updates amount to the largest portion of the commercial UAV industry and is estimated to reach EUR 4 Billion by 2035.[107] The services would thereby create an additional 250,000 to 400,000 jobs and the projected total economic impact of the UAV industry in Europe by 2050 is Euro 27 to 43 Billion.[108]

The exponential market growth of the commercial UAV industry is inevitable. In the words of Art Pregler, "[UAVs] are neither novel nor revolutionary, what is revolutionary is the economics." [109] UAVs are capable of completing tasks within a few hours, which would ordinarily take days to complete if carried out by humans. The rapid and precise gathering of

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[103] AUVSI Report *supra* note 81.
[104] *Ibid.*
[105] S*upra* note 52.
[106] SESAR, *European Drones Outlook Study: Unlocking the value for Europe* (EUROCONTROL, 2016) online: < www.sesarju.eu/sites/default/files/documents/reports/European_Drones_Outlook_Study_2016.pdf >.
[107] *Ibid.*
[108] *Ibid.*
[109] "Flying COWs and Other Drone Apps" *Harvard Business Review* (17 May 2017) online: <hbr.org>.

huge amounts of visual data in shorter periods for lesser costs, replacing humans to perform the mundane and highly dangerous tasks, [110] and considerable shortening of the production cycle in many industries have indeed revolutionized several business models. UAV economy is therefore disruptive.[111] In order to claim maximum benefits from the disruptive UAV economy, it is necessary that UAVs attain both regulatory and technological maturity. In a regulatory sense, complete integration to the national air space is essential and in a technological sense achieving full automation is important. Once fully autonomous UAVs are fully integrated into the national airspace is when the full economic potential of UAVs will be realized.

2.6 The need for regulation

Notwithstanding the abundant economic advantages and opportunities, the use of UAVs by the masses is not met with much enthusiasm. The level of public dissent is well demonstrated in the words of Judge Andrew Napolitano;

> "[t]he first American patriot that shoots down one of these drones that comes too close to his children in his backyard will be an American hero."[112]

The criticism and the negativity of the public towards UAVs were initiated due to their association with controversial military operations[113] followed by a series of disturbing incidents. For example, in 2015 a UAV with radioactive material landed on the Japanese Prime Minister's office roof,[114] and a small UAV landed in the US White House premises, causing a

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[110] Marshall *supra* note 7; Dulo *supra* note 36.
[111] Chris Anderson "Drones Go to Work" *Harvard Business Review* (May 2017) online: <hbr.org>.
[112] Steve Watson, *Judge Napolitano: First Patriot to Shoot Down a Government Spy Drone Will Be a Hero*, (May 16, 2012) online:<www.infowars.com> cited in Robert H. Gruber, "Commercial Drones and Privacy: Can We Trust States with Drone Federalism", 21: 4 Rich. J L &Tech. 1 (2014)
[113] Michael Calvo, "Uncertainty and Innovation: The Need for Effective Regulations to Foster Successful Integration of Personal and Commercial Drones" (2016) 22:1 Southwestern J Int'l L 189-208.
[114] *Supra* note 114.

serious breach of security.[115] Several cases have been reported where UAVs crashed onto people and property,[116] and people suffering serious injuries due to the sharp-edged rotors of UAVs.[117]

An increasing number of unethical and illegal acts such as voyeurism,[118] and drug smuggling[119] are widely reported resulting in grave concerns related to public safety, security, privacy, trespass and nuisance. Environmentalists state that given the nature of planned commercial operations, adding thousands of UAVs to the domestic airspace will present interruptions to flight patterns of migratory birds, disrupt wildlife, cause noise pollution leading to several negative spill-over effects. [120]

The arbitrary flying of UAVs in the proximity of aerodromes have caused severe inconvenience to air traffic leading to temporary closure of airports, grounding aircraft and delays.[121] Many cases have been reported of UAVs coming in close contact to passenger planes and helicopters, severely compromising the safety of passengers and pilots onboard.[122] The

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[115] Michael S. Schimdt & Michael D. Shear "A drone too small for radar to detect rattles the White House" *The New York Times* (26 January 2015) online: <www.nytimes.com>.

[116] Paul P. Murphy, "Charges possible in Space Needle drone crash" *CNN* (12 January 2017) online: <www.cnn.com> ; Andrew Blake, "Aerial photographer gets 30 days in prison for crashing drone into woman" *The Washington Times* (1 March 2017) online: <www.washingtontimes.com>.

[117]FAA Center of Excellence for UAS Research, *ASSURE UAS Ground Collision Severity Evaluation Final Report*, online: <www.assureuas.org>.

[118] Nick Bilton, "When your neighbor's drone pays an unwelcome visit" *The New York Times* (27 January 2016) online: <www.nytimes.coml>; Kim Min-joo, " 'Drone voyeur' arrested for filming naked bathers in Jeju" *The Korea Herald* (9 August 2017) online: <www.koreaherald.com>.

[119] Stephen Dinan, "Drones become latest tool drug cartls use to smuggle drugs into U.S." *The Washington Times* (20 August 2017) online; <www.washingtontimes.com>.

[120] Geoffrey Christopher Rapp, "Unmanned Aerial Exposure: civil liability concerns arising from domestic law enforcement employment of unmanned aerial systems" (2009) 85 North Dakota L Rev. 623 – 648. (The spillover effect will occur due to System components such as batteries and circuitry contain hazardous chemicals that could leach into ground water supplies in the event of crash or mishap); Carol M. Rose, "Planning and Dealing: Piecemeal Land Controls as Problem of Local Legitimacy", (1983) 71 Cal L Rev, 837. (discussing spillover effects).

[121] Roberta Pennington, "Dubai and Sharjah airports closed due to drone" *The National* (29 October 2016) online: < www.thenational.ae>. (Twice in 2016, the Dubai airport had to close its airspace and divert or ground flights due to unauthorized activity by UAVs carried out in proximity to the airport.); "Drone causes Gatwick Airport disruption" *BBC* (3 July 2017) online: < www.bbc.com> (Runway operations of Gatwick were suspended).

[122] Chris Young, "Drones have come dangerously close to mid-air collisions with B.C. planes 15 times this year" *National Post* (28 November 2014) online: < nationalpost.com > ; Rob Davies " Drone flew 'within wingspan' of plane approaching Heathrow" *The Guardian* (31 March 2017) online: <www.theguardian.com>; Woodrow Bellamy III "Drones Came Too Close to Airplanes 1,800 Times in 2016" *Avionics* (17 March 2017) online:< www.aviationtoday.com>.

worst fears of the aviation industry were confirmed when a small UAV collided with a Skyjet aircraft on descent to Jean Lesage International Airport in Quebec City, Canada,[123] marking the first collision between a UAV and a commercial plane. Although no severe damage has been reported till now, a study concluded by the UK government, found that the impact of a UAV collision is much severe than the damage caused by a bird of same mass and flying speed.[124] The ensuing mass negativity directed towards UAVs has created a substantial impediment to the process of absorbing UAVs to national airspace. Unless the public is convinced of the safety of UAVs, full integration to non-segregated airspace would not be feasible.[125]

The existing regulations, drafted for manned aircraft and operations conducted with a pilot onboard, cannot effectively control the diverse applications of UAVs and are inadequate. [126] Therefore, it is necessary for governments and civil aviation authorities to be proactive and think one step ahead, rather than waiting to set regulations in response to an incident or accident. However, notwithstanding the growing demand for consumer UAVs, rapid improvements in the technology and blooming economic opportunities, governments have been reluctant to fully integrate UAVs into national airspace.[127] Given the peremptory concern of aviation is safety, it is no surprise that governments are cautious when it comes to regulating a new and unprecedented technology. In many instances, governments have followed restrictive methods to control UAVs, including blanket prohibitions on commercial operations,

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[123] Travis M. Andrews, "A commercial airplane collided with a drone in Canada, a first in North America" *The Washington Post* (16 October 2017) online: < www.washingtonpost.com>.
[124] UK, Department for Transport & Military Aviation Authority, *Drones and manned aircraft collisions: test results* (July 2017) online: Gove.UK <www.gov.uk/government/publications/>.
[125] UK, House of Lords, *European Union Committee Report on Civilian Use of Drones in the EU*, 7th Report, 2014-2015 Sess.
[126]Bartsh, Coyne & Gray, *supra* note 5.
[127] Timothy M. Ravich, "The Integration of Unmanned Aerial Vehicles into the National Airspace" (2005) 85 North Dakota L Rev. 597;

> UAS operations have outpaced the law in that they are not sufficiently supported by a dedicated and enforceable regime of rules, regulations and standards respecting their integration into the national airspace.

mandatory registration of each unmanned aircraft, very high standards for remote pilots and maximum fines in the event of violating regulations. Such restrictive regulations have done more to harness the industry than to facilitate its growth.

The unmanned aerial technology offers endless business opportunities, solid economic benefits and paves for a sustainable and smart life style. The majority of the social, ethical and legal problems mentioned above, and discussed in detail in Chapter 3, are the repercussions of wrongful utilization of a promising technology.[128] It is therefore the responsibility of law makers and administrative authorities to exert best efforts, to achieve the balance between ensuring safety and minimising risks while encouraging the commercial potential of the UAV industry.[129]

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[128] Bharat Rao, Ashwin Goutham Gopi & Romana Maione “The Societal Impact of Commercial Drones” (2016) 45 Technology in Society 83-90.

[129] Timothy M. Ravich, "Commercial Drones and the Phantom Menace" (2014) 5:2 J of Intl Media and Entertainment L 175; Timothy T. Takahashi, “The Rise of The Drones: The Need for Comprehensive Federal Regulation of Robot Aircraft” (2015) 8 Alb. Govt L. Rev at 63.

3. PITCHING THE PROBLEM

3.1 Introduction

UAVs are inherently different to manned aircraft. Its "swarming, persistent presence, and the ability to be anonymous" [130] is unprecedented in civil aviation. The several natural limits imposed upon manned aircraft due to the involvement of a human pilot onboard do not apply to the UAV. As briefly mentioned in Chapter 2, the cohort of allegations against UAVs is expanding with the proliferation of UAVs. This chapter focuses on expanding on the nature and the scope of selected issues, mostly relevant to commercial UAV operations. The issues discussed herein are identified as the most problematic after the careful examination of several reported incidents, governmental press releases, policies and scholarship related to UAVs. The discussion is laid out with reference to the legal systems of Australia, Canada, US and the EU, as the said countries constitute the subject matter of the comparative analysis of regulations, presented in this thesis.

3.2 Safety concerns

Safety is the paramount concern of aviation and is defined to be "the state in which the possibility of harm to persons or of property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and safety risk management.[131] Aviation is never "completely free of hazards and associated risks."[132] Nevertheless, the ICAO centric aviation community has cultivated a strong safety culture amongst all stakeholders of civil and commercial aviation. As a result, air travel is statistically the safest mode of transportation.

[130] Patrice Hendriksen, "Unmanned and Unchecked: Confronting the Unmanned Aircraft System Privacy Threat through Interagency Coordination" (2013) 82:1 George Washington L Rev 207.
[131] ICAO, *Safety Management Manual*, Doc 9859 AN/474, 3rd ed, (ICAO,2013)
[132] *Ibid.*

Nevertheless, the rising use of commercial UAVs and the lack of adequate regulations pose severe challenges to the traditional methods of traditional aviation safety management. Upon a comprehensive survey in 2008, the US Government Accountability Office (GAO) concluded that UAS are incapable of meeting the safety standards set for manned aviation.[133] The conclusion of the GAO report is well reflected by the constant UAV accidents and incidents reported..[134] As at the time of writing this thesis, the Aviation Safety Network's 'drone database' reports seventeen (17) suspected and confirmed collisions of UAVs with aircraft.[135] Furthermore, UAVs have been accused of trespassing restricted areas (eg: UAV crash on the White House lawn[136] and the official residence of the Japanese Prime Minister[137]) which escalated safety concerns to the level of national security issues. Reportedly, unauthorized flying of UAVs has caused interference with emergency response operations,[138] triggered the suspension of commercial flights, and closure of airports leading to considerable economic losses.

The gravity of risks posed by UAVs to commercial aviation was experienced during the unfortunate incident of a small UAV colliding with a passenger airplane in Quebec City, in mid-air. . [139] As the UAVs used for commercial purposes are mostly less than 25kg in weight the impact of a collision is limited.[140] Yet, such crashes are still capable of causing damage to

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[133] US GAO, *Report to Congressional Requesters on Unmanned Aircraft Systems: Safety Federal Actions Needed to Ensure Safety and Expand Their Potential Uses within the National Airspace System* (May, 2008) online: <www.gao.gov/assets/280/275328.pdf>.

[134] Steve Miletich, "Man convicted in drone crash that injured woman during Seattle's Pride parade" *The Seattle Times* (13 January 2017) online: <www.seattletimes.com>; "Australian triathlete injured after drone crash" (7 April 2014) *BBC News* online: <www.bbc.com>; Larry Celona, Daniel Prendergast & Reuven Fenton, " Drone smashes through woman's apartment window" (26 February 2017) *New York Post* online: <www.nypost.com>.

[135] See online: Aviation Safety Network <aviation-safety.net/database/issue/drones.php>.

[136] *Supra* note 115.

[137] *Supra* note 114.

[138] Jeff Daniels, "Hobbyist drone disruptions, are becoming a problem in the California wild fires, says FAA" *CNBC* (16 October 2017) online: <https://www.cnbc.com>.

[139] Statement by Hon. Marc Garneau Minister of Transport (15 October 2017) online: Transport Canada: <www.canada.ca/en/transportcanada/>.

[140] UK CAA, *Drone Safety Risk: An Assessment* CAP 1627 (2018); FAA Center of Excellence for UAS Research, *ASSURE UAS Airborne Collision Severity Evaluation Final Report*, online: <www.assureuas.org>

the aircraft structure leading to compromise the airworthiness of an aircraft.[141] In particular, foreign object ingestion is a grave concern for air breathing propulsion systems and small UAVs flying in close proximity to aircraft could easily get sucked in, leading to catastrophic engine failure.[142]

The aftermath of primary safety hazards leads to secondary safety hazards such as release of dangerous chemicals from UAV payloads, sudden fires due to the combustible nature of Lithium Polymer batteries used in UAVs,[143] extensive damages to people and property caused from debris and, in the event of a sudden evasive manoeuvre by an aircraft, severe injuries and damages may occur to passengers and cargo onboard.[144]

Reason for a UAV safety hazard could be faulty avionics data systems and control software, failure of engine batteries or fuel, issues in propellers and electrical systems, interferences with the electromagnetic spectrum, breakdown of communication links, birds and weather, or intentional acts of terrorism. The popular notion in society is that UAVs are perfect for avoiding 'Germanwings' type disasters.[145] But the lack of professional training and standards for remote pilots, effects of boredom and momentarily loss of concentration could lead to human error in piloting UAVs.[146] Also, the increasing affordability of UAVs is the result of expendable and low-cost technology, resulting in less resilient and fragile

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141 Drone Safety Risk: An Assessment, *ibid.*

142 See generally Yangkun Song, Brandon Horton, & Javid Bayandor, *Investigation of UAS Ingestion into High-Bypass Engines, Part 1: Bird vs. Drone: Proceedings of the 58th AIAA/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Texas, 2017* (Texas: AIAA, 2017)

143 See e.g. "Drone crash starts forest fire in Arizona" *BBC Technology* (12 March 2018) online: <www.bbc.com>. See also R.A. Clothier & R.A. Walker "Safety Risk Management of Unmanned Aircraft Systems" in: Valavanis & Vachtsevanos *supra* note 39; Jay Gundlach, *Civil and Commercial Unmanned Aircraft Systems* (Reston: AIAA, 2016); Roger Clarke & Lyria Bennett Moses "The regulation of civilian drones' impacts on public safety" (2014) 30 Computer L & Security Rev 263 – 285; R. J. Wallace, & J. M. Loffi "Examining Unmanned Aerial System Threats & Defenses: A Conceptual Analysis" (2015) 2:4 Int'l J Aviation, Aeronautics, and Aerospace

144 *Ibid.*

145 France, Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile, *Final Report on Germanwings Accident* (24 March 2016). (co-pilot of Flight Airbus A320-211 registered D-AIPX operated by Germenwings, intentionally caused the flight to collide with the terrain of the French Alps. All crew and passengers onboard perished.)

146 ICAO, *Human performance considerations for Remotely Piloted Aircraft Systems (RPAS)*: *Remotely Piloted Aircraft Systems Panel (RPASP) 2nd Meeting (RPASP/2)* (Montreal: ICAO, 2015)

architecture.[147] Therefore, saturation of the airspace with unsafe, unreliable and dangerous UAVs must be avoided.

States have responded to the numerous safety issues upon the premise that civil and commercial UAVs should not pose greater hazards to people or property than equivalent manned aircraft.[148] Consequently, several States have taken steps to restrict commercial UAV activity to the extent of placing prohibitions at the initial stages of the regulatory process.[149] As explained in the detailed discussion on national level UAV regulations in Chapter 4, governments have adopted a risk-based approach to the promulgation of UAV regulations, resulting in an incremental process of integrating civil and commercial UAVs to the national airspace.

As the current safety related laws and regulations for UAVs are rudimentary, States have made attempts to enact comprehensive regulation addressing the standardization of the product and design of the UAV. For example, France, by its Ministerial Order of 17 December

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[147]Clarke & Moses *supra* note 143.

[148] ICAO, *Unmanned Aircraft Systems (UAS) Circular*, CIR 328, AN/190 (Montreal: ICAO, 2011)

> "The principal objective of the aviation regulation framework is to achieve and maintain the highest possible uniform level of safety. In the case of UAS, this means ensuring the safety of any other airspace user as well as the safety of persons and property on the ground."

CASA, *Unmanned Aircraft and Rockets, Unmanned Aerial Vehicle (UAV) Operations, Design Specification, Maintenance and Training of Human Resources*, AC101-1(0) (Canberra: CASA, 2002) [CASA, AC101-1(0)]

> "UAV operations should be as safe as manned aircraft insofar as they should not present or create a hazard to persons or property in the air or on the ground greater than that created by manned aircraft of equivalent class or category."

EASA, Policy Statement Airworthiness Certification of Unmanned Aircraft Systems (UAS) E.Y01301, (EASA,2009)

> "A civil UAS must not increase the risk to people or property on the ground compared with manned aircraft of equivalent category."

CAA, Unmanned Aircraft System Operations in UK Airspace: Guidance, CAP 722 (London: CAA, 2010).

"UAS operations must be as safe as manned aircraft insofar as they must not present or create a greater hazard to persons, property, vehicles or vessels, whilst in the air or on the ground, than that attributable to the operations of manned aircraft of equivalent class or category."

[149] See e.g. India, DGCA, Public Notice File No. 05-13/2014-AED (7th October, 2014) online <http://dgca.nic.in/public_notice/PN_UAS.pdf> (Referring to the safety and security threats posed by UAVs, the Indian DGCA prohibited the launching of UAVs to the Indian airspace for any purpose.); US DOT FAA, *Unmanned Aircraft Operations in the National Airspace System*, Docket No. FAA-2006-25714 online: <www.faa.gov/uas/media/frnotice_uas.pdf> (the FAA highlights the threats to safety and allows UAVs subject to FAA issued airworthiness certificates. The certificates were initially issued only in the experimental category); see Also Therese Jones, *Report on International Commercial Drone Regulation and Drone Delivery Services* (Santa Monica, CA: RAND Corporation, 2017).

2015, imposes an obligation upon UAV manufacturers to obtain type design certificates from the *Direction Generale de l'Aviation Civile* for specific UAV classes [150] The European Commission is progressing towards introducing geo-fencing for UAVs as a preparatory step to establishing its "EU-wide framework".[151]

High safety standards for UAVs are antecedent to gain widespread public acceptance and successful integration of UAVs to national airspace. .[152] , Yet, the governments must also be careful not to over burden an industry which is in its early stages of development.

3.3 Security threats

The global spreading of terrorism and wars has made aviation increasingly susceptible to security breaches. The rigidity of passenger screening procedures, restrictions on goods allowed on-board, high security on the air-side of airports, are results of the rising concerns in aviation security. Against such a backdrop, the proliferation of UAVs is an added burden to aviation security.[153]

The commercial-off the shelf UAVs of today are well-developed beyond the crude models controlled by a joystick, capable only of line of sight operations. It is possible for anyone to purchase a UAV equipped with GPS and waypoint navigation systems, smartphone and internet connection, high definition video and infrared thermal cameras with longer recording capabilities.[154] As reported, the Ukraine – Donetsk conflict is heavily dependent on commercial off-the-shelf UAVs [155] and the "Ukrainian military formed an aerial UAV

[150] *Arrêté du 17 décembre 2015 relatif à la conception des aéronefs civils qui circulent sans personne à bord, aux conditions de leur emploi et aux capacités requises des personnes qui les utilisent*, JO, 24 December 2015, 23897; (relating to the design of civil aircraft that circulate without any person on board, the conditions of their employment and the capabilities required of the persons who use them).
[151] European Commission, Press release, "Drones: Fresh efforts to put safety first" (29 September 2017) online: EC <http://europa.eu/rapid/press-release_IP-17-3401_en.htm>.
[152] Gundlach *supra* note 143.
[153] See generally *supra* note 133.
[154] *Supra* note 54.
[155] *Ibid,* Patrick Tucker, "In Ukraine, Tomorrow's Drone War Is Alive Today," *DefenseOne.com* (9 March 2015) online: <www.defenseone.com/> cited in *ibid.* ("Ukrainian military has made extensive use of commercial

reconnaissance unit…which initially relied entirely on commercially available models."[156] The non-state militant group of ISIS is reportedly using commercial UAVs such as the DJI Phantom FC40 for surveillance.[157]

As seen above, the weaponization of commercial and hobbyist UAVs is an emerging, critical issue. Occasions of civilians experimenting with hobbyist UAVs mounted with firearms have been reported.[158] Potential modifications to commercial UAVs can vary from carrying explosives and firearms to unnoticeable, hazardous chemicals. Given "the construction material, small size, and flight altitude of most hobbyist systems, they are rarely visible on radar and are therefore particularly difficult to detect."[159] Hence, hobbyist and commercial UAVs, within the possession of malicious actors could be lethal.[160] But the unavoidable problem is, with prices continuing to drop and operational requirements increasingly simplified, UAVs are easily accessible and can be operated by any person. [161]

Adding to the burgeoning security concerns are cyber threats and attacks. The minimal human involvement and heavy dependability on software, communication links and other digital components render UAVs extremely vulnerable to hacking, jamming and spoofing.[162] A cyber-attack can be constituted by the direct sabotage of the UAV system, interfering with the communication link leading to the incapacitation of the UAV, or manipulating the UAV to

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systems, including modified DJI Phantoms and other reconfigured hobbyist drones, in its conflict with the self-declared Donetsk People's Republic, a rebel group backed by Russia");

[156]Carl FischerstrÖm, "UAS in Ukraine" (Presentation delivered at Sensors Symposium in Stockholm on 20 September 2016), online: FMV </www.fmv.se/Global/Dokument/Nyheter%20och%20Press/2016/Sensorsymposium%202016/11_Fischerstrom_FMV_UAS%20in%20Ukraine_v2.pdf>.

[157] *Supra* note 54; Yasmin Tadjdeh, "Islamic State Militants in Syria Now Have Drone Capabilities," (28 August 2014) *National Defense Magazine* (blog) online:<www. nationaldefensemagazine.org/blog/Lists/Posts/>.

[158] Associated Press "Video of Gun-firing drone spurs investigation" (21 June 2015) online: You Tube < https://www.youtube.com/watch?time_continue=38&v=FI--wFfipvA>.

[159] *Supra* note 54; Jack Nicas, "Criminals, Terrorists Find Uses for Drones, Raising Concerns," *The Wall Street Journa*l, (28 January 2015) online: <www.wsj.com>.

[160] Kristin Bergtora Sandvik & Maria Gabrielsen Jumbert eds. *The Good Drone* (London: Routledge, 2017).

[161] See for e.g. *Do It Yourself Drones*, online: https://diydrones.com/.

[162] See generally, US FTC, Office of Technology, *Drones and Privacy* (13 October 2016).

behave in a manner contrary to its original purpose.[163] Hence, in a fraction of a second it is possible that a perfectly good UAV goes rogue!

Given the serious security concerns, it is unsurprising that States are constantly pressured to address UAV related security issues at a legislative or regulatory level.[164] Although the increasing accessibility and affordability, adaptability and the anonymity of UAVs pose a grave threat to security, issues such as weaponization of a commodity, cyber terrorism are neither novel nor exclusive to UAVs. In every State, there is a legal framework for the protection of national security, and prevention of terrorism, and UAV operators are not exempt from the application of such laws. It is therefore best to widen the scope of existing national security laws than to introduce additional UAV specific security regulations in addition to the already restrictive UAV regulations. .[165]

3.4 Privacy

Civil aviation has never been rid of complaints on spying helicopters, stealth aircraft, remote sensing capabilities and numerous other technologies, alleged of causing of privacy infringements. But the threat posed by UAVs is unique.[166] It is "not because [it is] a new form of technology, but because they involve a novel adaptation of existing technologies to create a device with a particular set of capabilities."[167] According to a survey conducted in 2014, potential privacy invasions are the utmost public concern against widespread use of commercial UAVs.[168]

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163 Deepika Jeyakodi, "Cyber Security" in Scott *supra* note 11 at 67; See also Jim Young, "Boeing & Italian hackers create spy drones able to crack computers via WiFi" *RT Question More* (22 July 2015) online: <www.rt.com/news>.

164 Takahashi, "Rise of the drones", *supra* note 129; Ethan N. Brown, "Please, Don't Let Me Drone on: The Need for Federally-Led and State-Collaborated Action to Promote Succinct and Efficient Drone Regulations" (2016) 26 Kan. J.L. & Pub. Pol'y 48; Nolan Chandler, "O Drone, Where Art Thou," (2017) 38:1 Whittier L Rev 239-256. (Calls FAA drone regulation minimal and the future regulations relaxed).

165 Chapter 4 & 5, *below*.

166 Dulo, *supra* note 36 at 225.

167 Scott *supra* note 11 at 53.

168 N. J. Warren, "Private Drone Use Causing Many to Worry, Chubb Survey Finds" *PR News Wire* (08 September 2014), online: <www.prnewswire.com/news-releases/>.

The payload of a UAV can be designed to include a wide array of sensors including high resolution cameras, thermal imaging devices, license plate readers, and laser radar (LASAR).[169] Embedding facial recognition or soft biometric recognition technologies enable accurate identification capabilities.[170] Due to the stealthier and much sophisticated nature, it is quite apt to echo Ryan Calo's sentiment that UAVs in fact "threaten to perfect the art of surveillance."[171]

Adding to the problem is the extensive capacity of UAVs to gather and relay information.[172] Be it a UAV deployed by a government agency to monitor adherence to law, a company using UAVs to capture aerial photographs for landscaping purposes or an individual flying a UAV for solely recreational purpose, its ability to collect, retain, use and disclose personal information cannot be undermined.[173] One can easily use such personal information to defame blackmail or other unethical and illegal purposes. Furthermore, the susceptibility of UAVs to hacking or remote interception,[174] could lead to mass invasions of privacy leading to serious security breaches.[175]

Governmental authorities using UAVs to establish public order[176] and private actors using UAVs for recreational and commercial purposes,[177] are heavily criticized for their lack of regard to privacy of people. Privacy activists repeatedly call upon governments to

[169] Richard M. Thompson II, *Report on Domestic Drones and Privacy: A Primer*, (Congressional Research Service, 2015).
[170] *Ibid*.
[171] M Ryan Calo, "The Drone as a Privacy Catalyst" (2011-2012) 64 Stanford L Rev Online 29; George Cho, "Unmanned Aerial Vehicles: Emerging Policy and Regulatory Issues" (2012 – 2013) 22 J.L. Inf. & Sci. 201.
[172] Rebeccah M. Scarf "Game of Drones: Rolling the Dice with Unmanned Aerial Vehicles and Privacy" (2017) Scholarly Works 1006 online: <http://scholars.law.unlv.edu/facpub/1006>.
[173] Ontario, Information and Privacy Commissioner, "Privacy and Drones: Unmanned Aerial Vehicles" (Ontario: Information and Privacy Commissioner, August 2012).
[174] *Ibid*.
[175] *Ibid*.
[176] Peter Finn "Domestic use of aerial drones by law enforcement likely to prompt privacy debate" *The Washington Post* (23 January 2011); Jennifer Quinn. "Police drones sparks debate over personal privacy," *The Toronto Star*, (5 February 2013); John Villasenor, "Observations from above: Unmanned Aircraft Systems and Privacy" 36:2 Harv. J. L. & Pub.
[177] *Ibid*.

promulgate comprehensive laws for protection of privacy.[178] Though governments have taken notice of the issue, we are yet to see a body of regulations specifically designed to safeguard privacy from intrusive UAV activities. Until then, privacy safeguards will be provided under the existing laws and judicial precedent of each jurisdiction.

Internationally, the right to privacy is recognized under the International Covenant on Civil and Political Rights (ICCPR).[179] The ICCPR recognizes that in the event of an interference or attack to one's privacy, there is a right to protection of the law.[180] Generally, the civil aviation regulator is not expected to safeguard privacy.[181] It is protected in the form of a fundamental right under a country's constitution,[182] under specific legislation or by tort law.

As seen in the case of US, the Fourth Amendment to the US Constitution[183] provides protection against "unlawful searches and seizures" and as decided in *Burdeau* v. *McDowell* the protection applies to governmental action.[184] The Fourth Amendment "provides the minimum legal requirements for a governmental authority when employing [UAVs]."[185] The

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178 American Civil Liberties Union, *Protecting privacy from aerial surveillance: Recommendations for government use of drone aircraft* (2011) online: ACLU <www.aclu.org/technology-and-liberty/report-protecting-privacy-aerial-surveillance-recommendations-government-use/> (According to the ACLU the use of UAVs raise very serious privacy issues and are pushing America "willy-nilly toward an era of aerial surveillance without any steps to protect the traditional privacy that Americans have always enjoyed and expected"); Bartsch, Coyne & Gray, *supra* note 5 at 89,

> "The Australian Council of Civil Liberties called on the Australian government to urgently deal with the privacy issues associated with [UAVs]. Regulations governing civilian [UAVs] had not kept pace with the rapid growth of the industry in Australia."

179 *International Covenant on Civil and Political Rights,*19 December 1966, 999 UNTS 171 art.17 (entered into force 23 March 1976) [*ICCPR*].

180 *Ibid*.

181 See e.g Australian CASA, "Flying drones/remotely piloted aircraft in Australia" online: CASA <www.casa.gov.au/aircraft/landing-page/flying-drones-australia>; Thompson II, *supra* note 169.

182 Global Internet Liability Campaign, *Report on privacy and human rights: An International Survey of Privacy Laws and Practice* online: GILC<gilc.org/privacy/survey/intro.html>; See e.g. US Const amend IV; Japan Const art.16; India Const art 21.

183 US Const amend IV;

> "[t]he right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated."

184 *Burdeau v. McDowell* 256 US 465 (1921) ("The Fourth Amendment gives protection against unlawful searches and seizures, and as shown in the previous cases, its protection applies to governmental action. Its origin and history clearly show that it was intended as a restraint upon the activities of sovereign authority, and was not intended to be a limitation upon other than governmental agencies").

185 Thompson II, *supra* note 169.

US courts are yet to decide on the applicability of Fourth Amendment protection for activities conducted by UAVs. However, by analogy to the three seminal cases of *Florida* v. *Riley*,[186] *Dow Chemical Co. v. United States*[187] and *California v. Ciraolo*[188] it can be argued that, the government UAVs conducting surveillance from a legal altitude does not constitute a violation of Fourth Amendment rights.[189] Interestingly, in latter cases such as *Kyllo v. United States*[190] and *United States* v. *Jones*,[191] concerning the use of advanced technologies for surveillance, the court has upheld Fourth Amendment protections, in favour of those subjected to surveillance. The contrast between the two approaches of the court creates uncertainty as to the legal status of a UAV embedded with high technology, engaged in aerial surveillance.[192] Also, the privacy issues created by the "potential ubiquity of UAVs go beyond the current Fourth Amendment jurisprudence,"[193] and therefore scholars have argued that minimal protections are not adequate, and a legislative response is much needed.[194]

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186 *Florida V. Riley* 488 US 445 at 450-51 (1989) ("Riley could not reasonably have expected that his greenhouse was protected from public or official observation from a helicopter had it been flying within the navigable airspace for fixed-wing aircraft.")

187 *Dow Chemical Co. v. United States* 476 US 227 at 239 (1986) ("We hold that the taking of aerial photographs of an industrial plant complex from navigable airspace is not a search prohibited by the Fourth Amendment.").

188 *California v. Ciraolo* 476 US 207 at 215 (1986) ("In an age where private and commercial flight in the public airways is routine, it is unreasonable for respondent to expect that his marijuana plants were constitutionally protected from being observed with the naked eye from an altitude of 1,000 feet. The Fourth Amendment simply does not require the police traveling in the public airways at this altitude to obtain a warrant in order to observe what is visible to the naked eye."

189 See also US, *The Future of Drones In America: Law Enforcement and Privacy Considerations: Written Testimony to the Senate Committee on the Judiciary* (20 March 2013) (Prof. Ryan Calo); Thompson II, *supra* note 169; Brandon Nagy, "Why They Can Watch You: Assessing the Constitutionality of Warrantless Unmanned Aerial Surveillance by Law Enforcement" (2014) 29:1 Berkeley Technology LJ 135.

190 *Kyllo v. United States*, 533 US 27 at 40 (2001) (holding that a search occurred when the police used a thermal imager, not in general public use, to "explore details of the home that would previously have been unknowable without physical intrusion"

191 *United States v. Jones*, 132 S Ct 945 at 954 (2012).

192 See generally Andrew B Talai, "Drones and Jones: The Fourth Amendment and Police Discretion in the Digital Age" (2014) 102:3 California L Rev 729.

193 Joseph J. Vacek, "Big Brother Will Soon Be Watching - Or Will He - Constitutional, Regulatory, and Operational Issues Surrounding the Use of Unmanned Aerial Vehicles in Law Enforcement" (2009) 85:3 North Dakota L Rev 673.

194 Troy Roberts, "On the Radar: Government Unmanned Aerial Vehicles and their Effect on Public Privacy Interests from Fourth Amendment Jurisprudence and Legislative Policy Perspectives" (2009) 49:4 Jurimetrics 491. (argues that the Fourth Amendment will only provide minimal protections, leaving the primary responsibility to legislative responses).

As constitutional safeguards apply only to the operations of a public authority, one needs to look at tort law to ascertain the liability accorded in the event of infringement of privacy by a private individual, company or other non-governmental activity. The *Restatement (Second) of Torts*,[195] stipulates liability for invasion of privacy in the event of an (i) intrusion upon seclusion, (ii) appropriation of one's name or likeness, (iii) publicity given to private life, and (iv) publicity placing person in false. As argued by Richard Thompson privacy implications of UAVs are more likely to be covered under (i) and (iii).[196]

The concern for protection of personal information has generally increased with the growth of technology.[197] But, national level measures to implement sufficient regulation for data protection upon the private sector remains inadequate. For example, the US "which accounted for almost 1/3rd of [UAV] industry revenues in 2016 and predicted to remain the largest end market for commercial UAVs up to 2022,"[198] is notable for not having adopted comprehensive laws but employs a fragmented approach to regulate sectors.[199]

The conundrum relating to laws addressing privacy implications discussed above is not peculiar to the US. Transport Canada requires UAV operators to fly UAVs legally and safely to "respect privacy of others and to not fly over private property or take photographs or videos without permissions".[200] Operators of UAVs are required to comply with laws of the state including the Privacy Act, which statutorily recognizes the tort of privacy.[201]

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[195] *Restatement (Second) of Torts* §652 B – E (1977).
[196] Thompson II *supra* note 169.
[197] See e.g. OECD, *The Privacy Framework* (OECD, 2013).
[198] Interact Analysis, *Commercial Drones in 2022- Our Predictions*, online: <www.interactanalysis.com/drones-market-2022-predictions/>.
[199] *The Federal Trade Commission Act*, 15 USC §§41-58 (prohibits unfair or deceptive practices and has been applied to offline and online privacy and data security policies); *The Health Insurance Portability and Accountability Act* , 42 USC §1301(regulating medical information); *The Financial Services Modernization Act* (15 USC §6801-6827 (regulating the collection, use and disclosure of financial information).
[200] Transport Canada, "Flying your drone safely and legally" online: <www.tc.gc.ca/eng/civilaviation/opssvs/flying-drone-safely-legally.html>.
[201] *Privacy Act*, RSBC 1996, c 373; *Privacy Act* CCSM 2008, c P125; *Privacy Act* RSS 1978, c P24; *Privacy Act* RSNL 1990, c P22.

Canada's *Personal Information Protection and Electronic Documents Act* (PIPEDA)[202] is a step forward. Embodying the fair information principles[203] the Act extends its application to "the collection, use or disclosure of personal information in the course of a commercial activity."[204] Hence, the Act can be applied to UAV operations and thereby provide the necessary safeguards to the right of privacy in Canada.

Australia, although a party to the ICCPR, does not provide a constitutional right to privacy.[205] Following the judicial thinking in the case of *Victoria Park,* [206] Australia has not accorded statutory recognition to the tort of invasion of privacy. Given the rise of "privacy invasive technologies like [UAVs]"[207] the Commonwealth House of Representatives standing committee and the Australian Law Reform Commission have recommended adopting a tort of privacy to guard people against the interfering acts of private operators of UAVs. But, to date no statutory recognition has been accorded to the tort of invasion of privacy.

With the introduction of a revision to its Commonwealth Privacy Act 1988[208] in 2012, Australia has extended the application of its Privacy Act to private sector organizations with an annual turnover above AUD 3 million per annum. The AUD 3 million threshold however, effectively bars the application of law to individual use of UAVs and small businesses.[209]

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[202] *Personal Information Protection and Electronic Documents Act* SC 2000, c 5; Canada, Office of the Privacy Commissioner, "Summary of Privacy Laws in Canada" online: <www.priv.gc.ca/en/privacy-topics/privacy-laws-in-canada/02_05_d_15/>.

[203] Canada, Office of the Privacy Commissioner, "PIPEDA fair information principles" online: <www.priv.gc.ca/en/privacy-topics/privacy-laws-in-canada/the-personal-information-protection-and-electronic-documents-act-pipeda/p_principle>. (The principles are Accountability, Identifying Purposes, Consent, Limiting Collection, Limiting Use, Disclosure and Retention, Accuracy, Safeguard, Individual Access, Challenging Compliance)

[204] Canada, Office of the Privacy Commissioner "PIPEDA in Brief" online: <www.priv.gc.ca/en/privacy-topics/privacy-laws-in-canada/the-personal-information-protection-and-electronic-documents-act-pipeda/pipeda>.

[205] Angela Daly, "Privacy in automation: An appraisal of the emerging Australian approach" (2017) 33:6 Computer L & Security Rev 836-846.

[206] *Victoria Park Racing & Recreation Grounds Co Ltd v Taylor* [1937] HCA 45; (1937) 58 CLR 479 (where the High Court did not want to create a precedent of people complaining neighbours peeping over a fence).

[207] Austl, Commonwealth, House of Representatives Standing Committee on Social Policy and Legal Affairs, *Report: Eyes in the Sky: Inquiry into drones and the regulation of air safety and privacy* (Canberra: Australian Government Publishing Service, 2014); Des Butler "The Dawn of the Age of the Drones: An Australian Privacy Law Perspective," (2014) 37:2 UNSWLJ 434.

[208] *Privacy Act 1988* (Cth).

[209] *Supra* note 205.

The European Union (EU) has adopted strict laws and regulations to safeguard privacy and protection of personal information. Article 8 of the European Convention for the Protection of Human Rights and Fundamental Freedoms (ECHR) guarantees the personal privacy of its citizens,[210] and the Member States include constitutional protections for privacy of their citizens. EU's position as to protecting privacy was well articulated in the European Court of Human Rights case *von Hannover vs. Germany (No.2)*[211] which upheld legitimate expectation of an individual to the protection of his private life. Hence, the regulations for safeguarding privacy are stronger in the EU. It was confirmed by the European Data Protection Supervisor (EDPS), that Dir. 95/46/EC (data protection directive),[212] Framework Decision 2008/977/JH[213] and relevant EU case law applies to UAV operations.[214] The data protection directive of the EU prohibits processing personal data without the prior consent of the subject. The prohibition is a strong shield to safeguard the privacy of individuals.

The protections are sought to be further strengthened by the General Data Protection Regulation (GDPR),[215] which supersedes the data protection directive. The GDPR makes a bigger impact on the UAV industry as it makes privacy-by-design and default mandatory.[216] Hence privacy protections become a priority in every step of the life cycle of a UAV and in all operations it is designed, programmed or built to conduct. In the perspective of the public, or those subjected to surveillance by UAVs, the protections are a welcome addition. But the

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[210] European Convention for the Protection of Human Rights and Fundamental Freedoms, 4 November 1950, 213 UNTS 221, art 8 (entered into force 3 September 1953) [*ECHR*].
[211] *von Hannover vs. Germany (No.2)*, No 40660/08, [2012] ECHR 228, 55 EHRR 15.
[212] EC, *Commission Directive 95/46/EC of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data*, [1995] OJ, L 281/45.
[213] EC, *Council framework decision 2008/977/JHA of 27 November 2008 on the protection of personal data processed in the framework of police and judicial cooperation in criminal matters*, [2008] OJ, L 350/60.
[214] Opinion of the European Data Protection Supervisor on the Communication from the Commission to the European Parliament and the Council on "A new era for aviation - Opening the aviation market to the civil use of remotely piloted aircraft systems in a safe and sustainable manner" - https://edps.europa.eu/sites/edp/files/publication/14-11-26_opinion_rpas_en.pdf
[215] EC, *Commission Regulation (EU) 2016/679 of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation)*, [2016] OJ, L 119/1.
[216] *Directive 2016/678*, *ibid* art 25.

question is whether the universal application of the provision over all UAVs impose an added burden upon the industry which is still at its infant stage.

It becomes evident when analysing the issue of privacy, that the existing legal regime in most countries, is a patchwork of different regulations and laws confusing both the UAV industry and the public. An unstable regulatory framework does not serve the purpose of safeguarding privacy but continues to stifle innovation. Therefore, a smart regulatory response is necessary from the government[217] so that, in the words of Ryan Calo, UAVs "could be just the visceral jolt society needs to drag privacy law into the twenty-first century."[218]

3.5 Trespass and nuisance

Claims of trespass and nuisance are often coupled with the allegation of privacy infringement. Likewise, laws of trespass and nuisance serve to safeguard the privacy of a person.[219] The nature of UAVs such as its ability to operate at much lower altitudes,[220] the possibility of interconnecting multiple UAVs to form a swarm, the ability to remain anonymous, defy the existing laws of trespass and nuisance as applicable to aviation.

In common law jurisdictions, trespass claims are largely governed under tort law. The United States has pioneered the development of tort law in regard of trespass and nuisance, with the advent of aviation. Deviating from the early common law maxim *cujus est solum ejus ext usque ad coelum*[221] which allowed the owner of land to claim infinite airspace rights above his land, the seminal case of *United States v. Causby* held that the landowner's airspace rights

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[217] See Chapter 5, *below,* for more on recommended regulatory response.
[218] Calo, *supra* note 171.
[219] Merinda E. Stewart "Privacy" in Scott, *supra* note 11.
[220] Michael N. Widener, "Local Regulating of Drone Activity, in Lower Airspace" (2016) 22 B U J Sci. & Tech. L. 239.
[221] For a discussion on the legal maxim see Yehuda Abramovitch, "The maxim *cujus est solum ejus usque ad coelum* as applied in aviation" 8:4 McGill L J 247.

extend to the immediate reaches of the surface necessary to use and enjoy the land.[222] *Causby* established a standard for the adjudication of trespass and nuisance claims, which has been adopted widely.[223] It is noteworthy that trespass occurs not by the mere presence of an aircraft in the immediate airspace, but if such aircraft causes substantial interference with the use and enjoyment of land.[224] The said principle was applied in the UK case of *Bernstein of Leigh v. Skyviews & General Ltd.*,[225] where it was held that taking photographs of the land from above, in that particular case did not constitute trespass.

Under common law, nuisance is actionable when a flight constitutes substantial and unreasonable interference to the use and enjoyment of one's property.[226] Therefore, it is likely that UAVs emitting constant noises due to the whirring of rotors and engines may provoke several nuisance claims. Mostly, UAVs are likely to give rise to private nuisance claims, founded upon the allegation that the UAVs interfere with the quiet and peaceful enjoyment of a private property.[227] With low altitude manoeuvring capabilities and over one million UAVs in the sky,[228] one can expect a multitude of trespass, nuisance and consequential claims.

UAV specific regulations introduced worldwide have adopted various methods of dealing with such issues and the common approach is to place a number of prohibitions upon UAVs.[229] . The gravity of the probable complications in relation to trespass and nuisance claims can be demonstrated by two recent cases in the US. Firstly, in the case of the Drone Slayer[230]

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[222] *United States v. Causby* 328 US 256 (1946); see also *Bernstein v Skyviews & General Ltd*, [1978] QB 479; *Griggs v. Allegheny County* 369 US 84 (1962).
[223] Gina Y Chen, "Reforming the Current Regulatory Framework for Commercial Drones: Retaining American Businesses' Competitive Advantage in the Global Economy" (2017) 37:3 Northwestern J of Intl L & Business 513.
[224] *Restatement (Second) of Torts* §159 (2) (1977).
[225] *Bernstein, supra* note 222.
[226] Alissa M. Dolan & Richard M. Thompson II, *Report on Integration of Drones into Domestic Airspace: Selected Legal Issues* (Congressional Research Service, 2013)
[227] Hillary B. Farber, "Keep Out! The Efficacy of Trespass, Nuisance and Privacy Torts as Applied To Drones, 33 Ga St U L Rev 359 (2017).
[228] US DOT, "FAA Drone Registry Tops One Million" online: DOT <www.transportation.gov/briefing-room/faa-drone-registry-tops-one-million>.
[229] See Chapter 5, *below*, for a discussion on the restrictive nature of national regulation.
[230] Kieran Corcoran, "Victory for Kentucky 'Drone Slayer' who took out aircraft flying over his home with a shotgun as case against him thrown out of court" *Daily Mail* (29 October 2015) online: <www.dailymail.co.uk/>.

a home owner in Kentucky shot down a private unmanned vehicle hovering above his home. The trial judge dismissed him of all charges, on the basis that the UAV was flying above private property and thereby intruding upon the privacy of the landowner.[231] The owner of the UAV was hence barred from claiming damages. The case was dismissed for lack of jurisdiction on appeal to the District Court of Kentucky,[232] and no pronouncement on the law as to trespass claims were made. But the case presents an opportunity to ponder upon a variety of legal issues that may arise; the rising vigilantes and anti – UAV technologies, the intentional damages caused to aircraft, claims for innocent right of passage over private property are examples of such contentious matters.

Secondly, the case of *Huerta v. Pirker*[233] ; a case in which the National Transportation Safety Board had to clarify that unmanned aerial vehicles are aircraft and therefore fall under the purview of FAA regulation. Although the case *Huerta v. Pirker* provided much needed certainty as to the status of a UAV, a point worth noting is that the case also upholds the authority of the FAA over a UAV flown below the conventionally regulated airspace. Hence the question arises, to which extent can the FAA regulate airspace, and does it effectively bar a landowner's private property rights in the airspace adjacent to his land?[234]

As seen above, proliferation of UAVs will lead to contradictions of established norms in property law. Waiting for the courts develop law would delay the regulatory process and thereby delay the integration of UAVs to national airspace. To solve the numerous property rights concerns, it has been proposed to delimitate the airspace as to the extent which private property rights will apply.[235] Theoretically, delimitation of the airspace is a good solution. But

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[231] *Ibid*.
[232] *Boggs v. Merideth* (Civil Action No.3: 16-CV-00006-TBR) (DC Kentucky, 2017).
[233] *Huerta v. Pirker* EA-5730, 2014 WL 8095629 (NTSB) online: NTSB<www.ntsb.gov/legal/alj/Documents/5730.pdf>.
[234] Michelle Bolos, "A Highway in the Sky: A Look at Land Use Issues That Will Arise with the Integration of Drone Technology" (2015) 2015:2 U of Illinois J of L, Technology & Policy 411.
[235] *Ibid*.

by analogy to the ongoing debate the Space Law domain,[236] introduction of a precise limit in airspace would be extremely difficult, if not impossible. However, it is notable that many national civil aviation regulators have already imposed a minimum and or maximum altitude to operate hobbyist and commercial UAVs.[237] Imposition of such an operational limit provides clarity on how to conduct UAV operations. But to impose strict airspace limitations at a stage where the many commercial operations (such as UAVs in delivery, construction inspection, landscape photography and journalism) have not reached the full potential due to regulatory restrictions, would be premature.

3.6 Liability issues

The widespread use of unmanned aerial vehicles for commercial activity will introduce considerable alterations to the manner airspace is exploited. The ensuing problems, including those discussed above, would result in many legal ramifications. Given the sharp contrast between manned aircraft operations and UAV operations, it would be interesting to see the development of law in determining liability. It is the intention of this thesis to present the following discussion, as a starting point to the development of scholarship addressing UAV liability.

UAVs might incur liability in many circumstances. According to the many incidents reported so far, UAVs are primarily prone to third party liability, caused by the direct physical impact upon a person, object or property on ground or mid-air. The commercial applications of UAVs might lead to damages claims for several issues including trespass, nuisance, privacy infringements and the interruption of radio frequencies. In the near future, UAVs may also be

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[236] Bin Cheng, "Legal Regime of Air Space and Outer Space: The Boundary Problem, Functionalism versus Spatialism: The Major Premises" (1980) 323, 335-38 (1980); He Qizhi, The Problem of Definition and Delimitation of Outer Space, 10 J. Space L. 157 (1982); Ram S. Jakhu, Tommaso Sgobba & Paul Stephen Dempsey eds., *The Need for an Integrated Regulatory Regime for Aviation and Space* (Wien: Springer-Verlag, 2011)

[237] See e.g. *infra* note 318; *infra* note 435.

liable under contracts of carriage of goods and passengers by air.[238] The claims will be decided under the local laws of each state or country.

Both internationally and nationally the legal status conferred to a UAV is that of an aircraft. Hence, arguably the law governing liability of manned aircraft is applicable to UAVs. But, due to the inherent differences of unmanned and manned aviation, the unequivocal application of existing laws and judicial precedent pertaining to liability in manned aviation to UAVs is questionable. The development of jurisprudence will be a mammoth task due to the broad spectrum of UAVs and the courts will have to pay attention to physical specifications such as the maximum take-off weight (MTOW), wingspan, payload, cruise speed; other characteristics including the level of control exercised by the remote pilot, real time situational awareness and available collision avoidance technology, to ascertain liability and assess damages.

The UAVs ability to maintain anonymity and the ensuing inability to identify the operator or the owner of a UAV can result in a fruitless effort to recover damages.[239] Given the frequency of accidents caused by UAV crashes, the lack of a method to identify the operator has created a negative public perception.[240] The registration requirement introduced in many national UAV regulations is therefore a sensible move.[241]

The UAV industry is still largely experimental and to ensure safe and reliable operations much commitment is necessary for research and development. Imposition of hard-fast rules of liability leading to punitive damages against the UAV industry, would lead to a premature burden and thereby throttle innovation. Currently, in comparison to a pilot on-board,

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[238] Stefan A Kaiser, "Third Party Liability of Unmanned Aerial Vehicles / Drittschadenshaftung bei Unbemannten Flugzeugen / Responsabilite des Tiers pour Dommage par Aeronefs sans Pilote" (2008) 57:2 Zeitschrift fur Luft- und Weltraumrecht - German J of Air and Space L 229.

[239] Anna Masutti, "Proposals for the Regulation of Unmanned Air Vehicle Use in Common Airspace" (2009) 34:1 Air & Space L 1.

[240] Eyes in the Sky *supra* note 207; Domen Bajde et al, *Public reactions to drone use in residential and public areas* (University of Southern Denmark,2017);

[241] See Chapter 5, *below*, for a discussion on national regulations.

a remote pilot lacks the same level of situational awareness, is heavily reliant on the communication link and may not be as specially trained, skilled nor professionally qualified for operating aircraft.[242] Conventional pilots are held to a higher duty of care due to their unique skill and professional training.[243] Expecting the same standard from a UAV pilot is unfair and unjust. Assessing the liability of a UAV pilot, according to the standard of care exercised by a 'reasonable person'[244] would better suit the early ages of remote piloting.

The progression towards autonomy and the decreasing level of control by the remote pilot over a UAV are factors to be considered.[245] In most claims for damages, liability is found in negligence of the operator. The legal principles are developed to address human shortfalls and errors. Establishing negligence on the part of a completely autonomous machine would thus require creative judicial thinking and the reassessment of existing laws.

a. Product liability[246]

A UAV crash, accident or any other incident causing damage to a person or object may occur due to several reasons including bad weather, human error or technical failures. In a recent study carried out by examining over 150 civil (non-military) UAV related incidents worldwide, it was found that "…[UAV] operations are more likely to experience (1) loss of control in-flight, (2) events during take-off and in cruise, and (3) equipment problems" , leading

[242] See generally Benjamin D. Mathews, "Potential Tort Liability for Personal Use of Drone Aircraft" (2015) 46 St. Mary's L J 573.
[243] *Webb v. United States*, 840 F. Supp. 1484 (D. Utah 1994), (the court held that "the pilot of the aircraft is directly and ultimately responsible for the operation of his aircraft. Pilots are charged with that which they should have known in the exercise of the highest degree of care."); See also *Taylor v. Alidair* (1976) IRLR 423; See generally, *Australia National Airlines Commission v. The Commonwealth of Australia and Canadian Pacific Airlines* (1974–75) 132 CLR 582.
[244] See *Blyth v. Company Proprietors of the Birmingham Water Works* 156 ER 1047 (Exchequer 1856). (holding that "Negligence is the omission to do something, which a reasonable man, guided upon those considerations which ordinarily regulate the conduct of human affairs, would do, or doing something which a prudent and reasonable man would not do.")
[245] See generally M. Nas, "Pilots by Proxy: Legal Issues Raised by the Development of Unmanned Aerial Vehicles" (2006) Unmanned Aircraft Technology Applications Research 25. online: UATAR<www.uatar.com/>.
[246] Note that the discussion in relation to product liability is centered around the US and EU regimes, on the assumption that as it represents the jurisdictions where most number of product liability claims could be brought forward. The assumption is made upon the current market shares and the pioneering regulatory initiatives of US and the EU.

to the conclusion that technology issues and not human issues are the key contributors to UAV incidents.[247] The pressure is therefore upon the manufacturer to upgrade technology and to design features to ensure safety.[248] In many jurisdictions, product liability laws impose strict liability on the manufacturer. Regulating the product design and architecture, would therefore result in sky-rocketing the number of potential claims against the UAV manufacturer.

The US, which pioneered the development of product liability under the common law, holds "legal actions are typically grounded in strict liability in tort or upon breach of any obligation or warranties associated with a contract".[249] A plaintiff is not required to prove negligence of the defendant but the defectiveness[250] of the product and the damage resulting from the defective product. Upon examination of the development of case law, a clear departure is traceable from fault-based liability of the manufacturer towards strict liability, and gradually adopting a favourable approach towards protecting the consumer.[251] Imposing strict liability upon the manufacturer had adverse effects on the industry and especially in general aviation where the manufacturers had to bear insufferable costs for product liability insurance and in some ended up in bankruptcy.[252] In response the *General Aviation Revitalization Act* was introduced, limiting product liability up to 18 years from production.[253] The defences available

[247]Graham Wild, John Murray & Glenn Baxter "Exploring Civil Drone Accidents and Incidents to Help Prevent Potential Air Disasters" (2016) 3:2 *Aerospace* 22.
[248] See e.g. FAA, UAS Identification and Tracking Aviation Rulemaking Committee, *Recommendations: Final Report* (30 September 2017) (recommends remote ID tracking capabilities for UAS); *infra* note 436 (France recommends an electronic light fitted to its UAVs).
[249] Laurence E. Gesell & Paul S. Dempsey *Aviation and the Law*, 5th ed (Arizona: Coast Aire Publications, 2011) at 717.
[250] On the notion of defectiveness see *The Restatement (Second) of Torts*, s.402A (1977).
[251] See *McPherson v. Buick Motor Company*, 217 NY 382, 111 NE 1050 (1916); *Henningsen v. Bloomfield Motors, Inc.*, 161 A 2d 69 (1960); *Esola v. Coca-Cola Bottling Co.* 150 P.2d 436 (Cal 1944); *Greenman v Yuba Power Products*, 377 P.2d 897 (Cal 1963).
[252] Gesell & Dempsey, *Aviation and the Law* at 740 – 744.
[253] *General Aviation Revitalization Act*, Public Law 103-298, [1994] USCCAN 108 State 1552.

to manufacturers are limited[254] and continued awarding of high damages to plaintiffs may discourage manufacturers in funding research and development.[255]

Similar to the US law, the EU Product Liability Directive imposes strict liability[256] and thereby eliminates the need to "to prove a contractual link, a duty of care or failure to take reasonable care to comply with relevant legislation"[257] by the injured party. And again, the Product Liability Directive offers limited defences to the manufacturer to exonerate it of strict liability.[258] Under the Product Liability Directive, the application of strict liability coupled with the notion of defectiveness as stipulated under Article 6,[259] can weigh heavily upon the UAV industry. It is noteworthy that recently in the *Boston Scientific* case[260] the CJEU found that potential defects can trigger product liability. Although the subject matter of the case does not relate to UAVs or aviation, the approach of the court is alarming.

Furthermore, Article 2 of the Directive defines products to be "all movables" and the European Commission has clarified that the directive applies to software.[261] But, it is uncertain whether the application of the Product Liability Directive is confined to software embedded to tangible devices or whether it expands to cover software as a service. As UAVs are prone to

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[254] *Bruce v. Martin-Marietta corp,* 554 F (2d) 442 (10th Cir. 1976).(State of the art defence); *Lewis v. Babcock*, 985 F (2d) 83 (2nd Cir. 1993) (Government contractor defence); *Braniff Airways v. Curtiss-Wright* 411 F (2d) 451 (2nd Cir. 1969)(Statute of limitations).

[255] See generally Peter Huber, *Liability: The Legal Revolution and Its Consequences* (Basic Books, 1990); G. Parchomovsky & A. Stein "Torts and innovation," (2008) 107 Michigan L Rev 285-315; M. E. Porter, *The Competitive Advantage of Nations* (New York: Free Press, 1990), (republished with a new introduction, 1998) cited in Alberto Galasso & Hong Luo, "Punishing Robots: Issues in the Economics of Tort Liability and Innovation in Artificial Intelligence" in Ajay K. Agrawal, Joshua Gans, & Avi Goldfarb, eds. *The Economics of Artificial Intelligence: An Agenda* (Chicago University Press, forthcoming, 2018).

[256] *EC, Commission Directive 85/374/EEC, of 25 July 1985 on the Approximation of the Laws, Regulations and Administrative Provisions of the Member States Concerning Liability for Defective Products*, 1985 OJ, L 210/29, art. 1.

[257] European Commission, *Evaluation of the Directive 85/374/EEC concerning liability for defective products,* (European Commission, 2016).

[258] *Directive 85/374/EEC supra* note 256, art. 7.

[259] *Ibid*, art. 6 (when a product "does not provide the **safety which a person is entitled to expect**" [emphasis added]).

[260]Judgment of the Court of 5 March 2015 in Joined Cases C- 503/13 and C- 504/13, *Boston Scientific Medizintechnik GmbH v AOK SachsenAnhalt — Die Gesundheitskasse, Betriebskrankenkasse RWE*, C-503/13, C-504/13, ECLI:EU:C:2014:2306.

[261] EC, *Answer given by Lord Cockfield on behalf of the Commission to the Written Question No 706/88 by Mr Gijs de Vries on 15 July* [1989] OJ C 114/1 at 42.

"risks relating to the failure of operating software enabling … [the] function [of the UAV], risks relating to network failures, risks related to hacking and cybercrime, and …external factors relating to programming choices," further clarification as to the application of the Product Liability directive is necessary.[262]

As exemplified in the above discussion, the product liability regime is biased towards safeguarding the consumer and does not sufficiently address the technological improvements or industry's needs. Assigning liability and accountability to UAVs is often identified as a way to instigate trust in UAVs within the masses.[263] But, in an era where the global society is heading towards the fourth industrial revolution,[264] legal thinking should not be confined to safety-centric doctrines but explore the risks and strategize risk aversion and mitigation. Thus, it is time for the regulators and the law makers to move away from the urge to use product liability as a tool only to ensure safety, but also to encourage innovation.

3.7 Insurance

The increased use of commercial UAVs and the many problems discussed hitherto, portend a growing list of vulnerabilities and a large volume of potential liability claims. In relation to UAV operations, claims may primarily arise for damages occurring due to loss of control of UAVs leading to accidents arising from negligent piloting, mid-air collisions, and intentional use of UAVs to target critical infrastructure, data protection issues and other public concerns such as safety and privacy infringements, trespass and privacy.[265] In relation to manufacturing, insurance is essential due to the strict product liability regimes. Regulatory

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[262] Tatjana Evas, *Study: The European added value of a common EU approach to liability rules and insurance for connected and autonomous vehicles: European Added Value Assessment* (European Added Value Unit -EPRS, EU Parliament, 2018).
[263] *Supra* note 128.
[264] See generally World Economic Forum "The Fourth Industrial Revolution: What it means and how to respond" online: WEForum <www.weforum.org/>.
[265] Allianz Global Corporate & Specialty, *Rise of the* Drones: *Managing the Unique Risks Associated with Unmanned Aircraft Systems Report* (Munich: Allianz, Global Corporate & Speciality SE, 2016).

authorities often resort to imposing high fines and penalties in the event of a violation of regulation.[266] Having a comprehensive insurance coverage is therefore a safety net for the young UAV industry. In some countries including Canada, obtaining insurance coverage prior to the commencement of any commercial UAV activity is mandatory.[267]

However, in practice, obtaining insurance against a UAV accident or incident was seemingly impossible for many claimants due to the aviation exclusion clause generally embedded in insurance policies for life, general business risks and homeowners.[268] The insurance industry has been slow to embrace commercial UAVs. In the words of Darryl Jenkins, an analyst for the Aviation Consulting Group:

> Insurance is the 800-pound gorilla in the room no one is talking about… insurability is a necessary event before businesses can successfully use UAS [unmanned aerial systems] in the National Airspace System … because no business is going to want to be on the line for the liability concerns… Insurability will determine which sectors of the UAS market will grow and which will die.[269]

The volatile nature of regulations, lack of historical data, and the unavailability of accurate and comprehensive risk assessments, have rendered ascertaining UAV insurability particularly

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266 See e.g Bart Jansen, "Drone-photography company fined $200,000 by FAA" *USA Today* (17 January 2017) online: <www.usatoday.com/>; Steven Flynn "15 Drone Fines from around the world *Drone Tango* (6 October 2016) online;<skytango.com/15-drone-fines-from-around-the-world/>.

267 Transport Canada, *Advisory Circular on Guidance Material for Operating Unmanned Air Vehicle Systems under an Exemption*, AC 600-004, s. 4.1 (4).

268 See Amanda Dean, the Atlantic vice president of the Insurance Bureau of Canada;

> "Liability arising from drones and drone usage for commercial purposes would generally not be covered in a typical commercial policy…business insurance coverage, as they would fall within the aviation exclusion of a general liability policy."

quoted in David Burke, "Boom in Drones triggers insurance liability coverage requirements" *CBC* (18 March 2016) online:<www.cbc.ca/news/canada/nova-scotia/drones>; Ingrid Sapona, *Paper on Drones: The Latest Buzz in the Insurance Industry* (August 2015), online:<www.insuranceinstitute.ca/en/cipsociety/information-services/advantage-monthly/0815-drones>.

269 Brianna Ehley, "What's grounding the commercial drone industry?" *The Financial Times,* 21 May 2013, online: <www.thefiscaltimes.com/>; Helicopter Association International "Insurability of UAVs: The "Gorilla in the Room" *Rotor News,* (21 August 2013) online: <www.rotor.org/Publications/RotorNews/tabid/843/articleType/ArticleView/articleId/3393/Insurability-of-UAVs-The-Gorilla-in-the-Room.aspx>.

hard.[270] According to the current industry practices an insurance underwriter is required to pay attention to "identifying and quantifying any specific hardware weaknesses of the UAV sought to be insured…[including] the quality of the electrical, engine, and propeller systems"[271] when providing hull insurance.

In general liability insurance coverage, it is necessary to pay attention to the type of the UAV, the purpose for which it is utilized, payload specifications and the legality of the operation. It is also necessary to focus upon the training, licenses and the experience of the UAV operator.[272] Nevertheless, insurance underwriters are still heavily challenged by the vast diversity of potential liability claims and the lack of solid legal definitions, limitations and parameters for commercial UAV operations.

A favourable development to the UAV industry is that despite the looming uncertainties, many insurance providers have identified the market potential and have come forward to offer special insurance coverage for commercial UAVs operators and manufacturers.[273]. The current insurance policies primarily address potential claims arising from collisions, accidents or other physical harm that may result from the use of commercial UAVs. But, what is not sufficiently addressed in current insurance policies and a major concern should be is providing insurance coverage for potential data losses. Considering the reliance of UAVs on its communication link and the move towards autonomous UAVs, insurers will have to address the potential issues such as attacks by hackers, spoofing and interferences caused to the radio frequency spectrum.[274]

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[270] Allianz Global Corporate, *Rise of the Drones, supra* note 265.
[271] David K. Beyer, et al., *Risk, Product Liability Trends, Triggers, and Insurance in Commercial Aerial Robots: Proceedings of the We Robot Conference on Legal & Policy Issues Relating to Robotics, University of Miami School of Law, 2014* (Miami: University of Miami School of Law, 2014).
[272] *Ibid*.
[273] Allianz Global Corporate & Specialty, Press release, "Growth in Commercial Drones Bring Multiple Benefits Along with New Risks, Allianz Warn" (13 September 2016) online: <www.agcs.allianz.com/> (Assuming growth projections for the commercial industry materialize, there is potential for the drone insurance market to be worth $500m+ by the end of 2020 in the U.S. Globally, its value could approach $1bn.).
[274] *Supra* note 271; Dulo *supra* note 36 ch 14.

In conclusion it needs to be reminded that even though "[insurance] companies are already providing offerings, it seemingly remains premature to estimate, to a scientific certainty, feasible coverage options."[275] But, one cannot expect private companies to manufacture and distribute commercial UAVs without safeguards. At a time where no governmental concessions such as a liability cap or indemnity is available for commercial UAV manufacturers or operators, insurance plays a crucial role in providing the necessary boost and encouragement to the UAV industry.

3.8 Conclusion

Operation of UAVs cause a cohort of issues as alluded above. Pointing to the severity of safety hazards posed by UAVs, arguments are made to the effect that UAVs are inherently dangerous. [276] Specific regulations for UAVs are necessary to mitigate risks, bring about control over the increased use of airspace and enable society to benefit from UAV operations. The regulations should not be overbearing and unduly expensive but proportionate to the risks and enforceable.[277]

[275] Carol P. Michel, Frederick N. Sager, Jr. & Kyle R. Jackson, Sr., *Paper on The Development of Drones:The Regulations, Risks, and Coverage Issues Associated with Evolving Aviation Technology*" (Weinberg, Wheeler, Hudgins, Gunn & Dial, LLC).
[276] Roger Clarke, "Appropriate regulatory responses to the drone epidemic" (2016) 32:1 Computer L & Security Rev 152.
[277] *Ibid.*

4. UAV REGULATIONS OF SELECTED JURISDICTIONS

4.1 Introduction

The demand for commercial UAVs is accelerating. A 2018 market study predicts a global commercial UAV market worth of USD 17 Billion by 2024.[278] According to industry estimates the integration of artificial intelligence to UAV technology can serve as a major catalyst for revenue growth.[279] As presented in the last chapters, increasing interest in commercial UAVs generate both opportunities and serious issues. States are constantly urged to bring about a balance between the good and bad of the UAVs through regulation.

Over 80 countries have already introduced UAV specific regulations. *Prima facie,* the regulations are safety oriented, strict and restrictive towards commercial applications of UAVs. It is not to say that no progress is visible, as States renew its UAV regulations to gradually allow commercial UAV operations. But, to-date the biggest impediment, preventing commercial UAVs from reaching its full potential is regulatory restrictions.

The aim of this chapter is to conduct a detailed analysis of the UAV regulations in Australia, Canada, United States and Europe, with the aim of identifying best practices promoting commercial UAV operations. The analysis is confined to the States mentioned above, due to the limited scope and length of this thesis. The States are chosen due to the comprehensive and pioneering nature of the regulations and the ease of access to necessary governmental documents, policies and administrative decisions to carry out an in-depth analysis.

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[278] Global Markets Insight Inc., *Commercial Drone Market Outlook: UAV Industry Size Forecast 2024* (Delaware: Global Market Insights Inc., 2018).
[279] *Ibid.*

As succinctly put by Bartsch (2015), "it is no revelation that aviation and regulation are intrinsically linked."[280] From the inception of aviation, governments have been challenged with managing change in a highly technological industry. Nevertheless, the exponential growth of UAVs has generated a host of inimitable issues indicating an urgent need for governmental response in a manner unlike any other event in the history of aviation.

Takahashi (2015), emphasizing the threats posed by UAVs to privacy and security, calls for rigid regulations.[281] Similarly, Perritt and Sprague (2015) in their extensive research article identify, that a strict approach is often employed by authorities when regulating UAVs, due to the lack of confidence in the technology.[282] They also suggest the imposition of strict regulations at the point of sale of UAVs.[283] But, restrictions at the point of sale could ultimately lead to unnecessary burden upon the manufacturer and the distributors and ultimately lead to impediments on the market entry of UAVs. Unfortunately, such obstructions would curb the growth of commercial UAV operations.

On the contrary, Ravich (2014) criticizes the restrictive approach of regulatory authorities by reference to the pre-2016 prohibition over commercial UAVs in the US. He correctly identifies the regulatory approach of the government is precautionary, based on the "public's psychological aversion to particular aviation technologies," and recommends flexible regulations.[284] Similarly, Volovelsky (2014) carrying out a case study on Israel, posits that since the UAV industry is in its infancy, "legislatures and courts need not rush to enact strict laws and rulings,"[285] and calls upon governments to initiate a public discussion between all

[280] R. I. C. Bartsch, "Unmanned and Uncontrolled: The Commingling Theory and the Legality of Unmanned Aircraft System Operations" (2015) 4:1 J Aeronaut Aerospace Eng 140.
Takahashi, "The Rise Of The Drones, *supra* note 129.
[282] Henry H. Perritt Jr & Eliot O. Sprague, "Law Abiding Drones" (2015) 16 Colum Sci & Tech L Rev at 383
[283] *Ibid*.
[284] Ravich,"Phantom Menace" *supra* note 129.
[285] Uri Voloveslsky, "Civilian uses if unmanned aerial vehicles and the threat to the right of privacy" (2014) 30 Computer L Sec Rev 306 – 320.

stakeholders for the formulation of voluntary rules and guidelines for UAV manufacturers and users so that such practices could ultimately crystalize into law and regulation.[286]

Clarke (2016) summarizes the wide-ranging implications of UAVs under six principles to advocate the need for a comprehensive regulatory framework.[287] Accordingly, Clarke posits that UAVs are inherently dangerous, operators of UAVs are capable of causing serious accidental harm due to lack of expertise, the payloads carried by UAVs may perform socially or economically harmful acts, and the increased commoditization of UAVs render rapid and widespread growth of UAV operators. He also argues that the regulatory measures must be proportionate and should not be unduly expensive for the industry. Hence, it is sufficient to introduce new regulations only where it is necessary and take advantage of the laws and regulations already in existence. [288]

Furthermore, scholars have continued to propose various new regulatory standards including taxation schemes,[289] airworthiness and type certification requirements,[290] training requirements for both local and foreign pilots,[291] mandatory technological measures to be added to the design of UAVs[292] and many more.

As indicated by the discussion above, scholars have called for regulations restricting UAV activity to safeguard privacy, security and other social concerns, or to promote UAV activities while achieving the balance between the pros and cons of UAVs. The proposition of this thesis is that, calling for comprehensive regulation which does not promote the integration of UAVs to national airspace, adds burden to the insipient UAV industry. Over regulation fails to achieve a symbiosis between the innovators, government and the market and would only

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[286] *Ibid.*
[287] Clarke, *supra* note 276.
[288] *Ibid*
[289] See Jeremy Straub, Vacek, Joe & Nordlie, John. 'Considering Regulation of Small Unmanned Aerial Systems in the United States' (2014) 39: 4-5 *Air & Space Law* 275–294.
[290] Timothy T Takahashi, "Drones in the National Airspace" (2012) 77:3 J of Air L and Commerce 489.
[291] Veronika Szikora; Gabor Szilagyi, "New Dangerous Practice on the Horizon: Legal Aspects of Drone Usage" (2017) 51:2 Zbornik Radova 499.
[292] Nolan Chandler, "O Drone, Where Art Thou" (2017) 38:1 Whittier L Rev 239.

vitiate the many opportunities and benefits of commercial UAVs. [293] Hence the following attempt is to examine the regulations introduced by various governments, in order to identify the best way forward.

4.2 Australia

a. Introduction

Australia is an important factor in civil aviation, responsible for managing 11% of the global airspace. Civil aviation is regulated by an independent statutory body; the Civil Aviation Safety Authority (CASA).It was established under the *Civil Aviation Act 1988* (CAA 1988).[294] As stipulated by the CAA 1988, its main object is to establish a regulatory framework to ensure aviation safety[295] and CASA is thereby vested with the power to implement of the civil aviation regulations. Such regulations are made under the authority of the CAA 1988, in the form of *Civil Aviation Regulations 1988* (CAR) and *Civil Aviation Safety Regulations 1988* (CASR) provide the general regulatory framework for civil aviation in Australia. . CASA is further empowered under the CAA, CAR and CASR to issue Civil Aviation Orders detailing matters of regulation and Manuals of Standards to provide technical material.[296]

b. Overview of the initial UAV regulations

In 2002, Australia became one of the pioneering countries to introduce official UAV specific regulations,[297] by way of Part 101 of the CASR titled 'Unmanned Aircraft and Rocket Operations.'[298] The regulations provided a basic legal framework for the operation of UAVs in

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[293] See generally, Anthony Falzone, "Regulation and Technology" (2013) 36:1 Harvard JL & Pub Pol'y 105.
[294] *Civil Aviation Act 1988* (Cth), s 8.
[295] *Ibid*, s. 3A;

> The main object of this Act is to establish a regulatory framework for maintaining, enhancing and promoting the safety of civil aviation, with particular emphasis on preventing aviation accidents and incidents.

[296] Civil Aviation Safety Authority, online: CASA <www.casa.gov.au/>.
[297] Bartsch, Coyne & Gray, *supra* note 5.
[298] CASA, "CASA and Remotely Piloted Aircraft" online: <www.casa.gov.au/aircraft/standard-page/casa-and-remotely-piloted-aircraft>.

Australian airspace, and were supplemented by the Advisory Circulars which explained the regulations by providing interpretations.

Part 101 regulations centred round the distinction between model aircraft and UAV, where the defining feature was whether the application was for recreational purposes or commercial activity.[299] In the event a UAV was purely used for recreational purposes, it was considered a model aircraft. The commercial use of UAVs was allowed subject to an operator certificate[300] and a controller certificate[301] issued by the CASA. "Unless with prior approval, both model aircraft and UAVs were confined to flying at an altitude no greater than 400ft above ground, outside controlled airspace, above non-populous areas[302] and at a distance greater than 5.5km from an aerodrome." [303] It is noteworthy that even at a very early stage of Australian regulation the term UAV was defined broadly to include the unmanned aircraft, ground control system, communications/datalink system, the maintenance system and the operating personnel.[304]

CASA's regulations were based on three weight classes. UAVs weighing less than 100g were micro UAVs and were largely exempt from regulation.[305] Small UAVs ranging between 100g – 150kg were, in certain conditions allowed to be flown without any form of certification. Larger UAVs weighing 150kg or more were subject to registration, a certificate of airworthiness, and only to be flown by qualified and licensed remote pilots.

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[299]CASA, *Advisory Circular on Unmanned Aircraft and Rockets: Model Aircraft*, AC 101-3(0), s.9.1.2. (commercial activity is;

> "one in which financial benefit is received from the service provided by the aircraft, other than financial benefit received for teaching the sport of flying model aircraft.").

[300] See *Civil Aviation Safety Regulations 1998* (Cth), reg.101.270

[301] See *ibid*, regs 101.F.3, 101.335(1) (f) & 101.340(1) (a).

[302] See *ibid*, reg. 101.235 (3).

[303] Scott, *supra* note 11 at 169.

[304] CASA, *supra* note 299, s. 4.2;

> "The UAV comprises not just the aircraft, it also consists of the UAV ground control system, communications/datalink system, the maintenance system and the operating personnel."

[305] See *Civil Aviation Safety Regulations 1998* (Cth), reg 101.235 (3)

As evident by the early regulations, Australia's initial focus was primarily on larger UAVs and the need to ensure they adhere to rigid safety standards.[306] Recognizing the rise of small UAVs to prominence, and the increasing relevance of commercial UAV applications, Australia continued to review its regulations. The reviews led to substantial amendments in the Australian UAV regulations.

As enumerated in the objective of the post implementation review of 2011,[307] CASA proposed amendments to CASR Part 101 in two phases. Phase 1 was to ensure that "aviation safety requirements are up to date and …the terminology [is] consistent with ICAO."[308] In order to implement Phase 1, CASA published a Notice of Proposed Rule Making (NPRM) in 2014[309] suggesting a risk-based framework and calling for comments.[310] Consequently substantial amendments were introduced to Part 101 in March 2016. CASA now plans to introduce completely novel regulations by way of CASR Part 102 under phase 2.[311]

c. Current UAV regulations

Significant amendments to the CASR Part 101 were finally introduced in March 2016, which became effective from September 2016.. Aligning with the terminology of the ICAO,

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306 James Coyne, *Working Paper on UAS Regulatory Developments in Australia*, online: ICAO <www.icao.int/Meetings/UAS/Documents/Coyne-James_CASA_Australia_WP.pdf>.

307 CASA, *Review of Regulations and Guidance Material relating to Unmanned Aircraft Systems (UAS),* Project OS 11/20, online: CASA<www.casa.gov.au/standard-page/project-os-1120-review-regulations-and-guidance-material-relating-unmanned-aircraft>.

> "The project objective is to provide an up to date regulation and more comprehensive guidance to industry on the regulatory requirements and approval processes for commercial operation of RPAS in Australia. The amended regulation and guidance material will consider the long-term integration of RPAS into normal aviation operations in all classes of airspace."

308 *Ibid.*

309 CASA, *Remotely Piloted Aircraft Systems,* NPRM 1309OS, online: CASA <https://www.casa.gov.au/standard-page/nprm-1309os-remotely-piloted-aircraft-systems>.

310 *Ibid.*

311 *Supra* note 307.

[312] the current Australian regulations use the terms 'RPA'[313] and 'RPAS'[314]. The classification has been extended to encompass the spectrum of smaller UAVs as well. The current Australian weight classes are micro RPAs, very small RPAs, small RPAs, medium RPAs and large RPAs. [315] The inclusion of smaller weight classes in its classification gives an edge to the regulator when it comes to controlling the fast growing commercial UAV applications.

There remains a general prohibition over hazardous operation of unmanned aircraft,[316] and other restrictions include flying the UAV in or over prohibited areas,[317] above 400ft,[318] Beyond Visual Line of Sight (BVLOS),[319] in the vicinity of aerodromes[320] and autonomous aircraft.[321] As emphasized in CASR, violation of the said restrictions can result in an offence of strict liability.[322]

The RPA specific regulations are stipulated under subpart 101.F bearing the title 'Remote Piloted Aircraft', which is applicable to very small, small, and medium RPAs used

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[312] *Supra* note 30.

[313]*Civil Aviation Safety Regulations 1998* (Cth)., v 5 ("*RPA* means a remotely piloted aircraft, other than a balloon or a kite.)

[314] *Ibid*, (*RPAS* (short for remote pilot aircraft system) means a set of configurable elements consisting of a remotely piloted aircraft, its associated remote pilot station (or stations), the required command and control links and any other system elements as may be required at any point during the operation of the aircraft.")

[315]*Ibid*; CASA, *Advisory Circular on Remotely piloted aircraft systems – operation of excluded RPA (other than model aircraft*), AC 101-10;

> micro RPA means an RPA with a gross weight of 100 g or less.
> very small RPA means an RPA with a gross weight of more than 100 g but less than 2 kg.
> small RPA means an RPA with a gross weight of at least 2 kg but less than 25 kg.
> medium RPA means:
> (a) an RPA with a gross weight of at least 25 kg but not more than 150 kg; or
> (b) a remotely piloted airship with an envelope capacity of 100 m^3 or less.
> large RPA means any of the following:
> (a) a remotely piloted aeroplane with a gross weight of more than 150 kg;
> (b) a remotely piloted powered parachute with a gross weight of more than 150 kg;
> (c) a remotely piloted rotorcraft with a gross weight of more than 150 kg;
> (d) a remotely piloted powered-lift aircraft with a gross weight of more than 150 kg;
> (e) a remotely piloted airship with an envelope capacity of more than 100 m^3.

[316] *CASA 1998* (Cth). reg 101.055

[317] *Ibid,* reg.101.065

[318] *Ibid,* reg.101.070

[319] *Ibid,* reg.101.073

[320] *Ibid,* reg.101.075

[321] *Ibid,* reg.101.097

[322] For *strict liability*, see *Criminal Code Act 1995* (Cth). s.6.1.

for purposes other than sports and recreation, and large RPAs. [323] It is stipulated that unless it is an 'excluded RPAs' (explained below), persons flying RPAs for commercial/ non recreational purposes must obtain a Remote Pilot's License (RPL) [324] and to carry out commercial operations, the company or business entity indenting to do so must have an RPA Operator's Certificate (ReOC). Additionally, to operate large RPAs, one needs a special certificate of airworthiness.[325] The RPLs and ReOCs are granted to persons and entities satisfying the eligibility criteria as stipulated in the regulations.[326] Australia does not impose any age limitation to persons applying for RPLs.

The introduction of 'excluded RPAs'[327] which allows certain low-risk RPAs to operate without specific authorizations from CASA[328] is a notable development. Micro RPAs, very small RPAs for sport and recreation operated in standard conditions, small and medium RPAs operated over the owner's land for many purposes including photography, agriculture, carriage of cargo where no remuneration is received, are amongst the excluded RPA operations.[329] The rationale for identifying certain categories as excluded RPA operations is based upon the findings of a research commissioned by CASA which provides the "risk-based assessment necessary for CASA to permit limited commercial-like RPAS operations." [330] The standard

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[323] Reg. *Civil Aviation Safety Regulations 1998* (Cth). reg 101.235 – Application of Subpart 101.F
[324] *Ibid*, reg.101. 252
[325] *Ibid*, reg.101.254
[326] *Ibid*, regs. 101.F.3 (Remote pilot licenses) & 101.F.4 (Certification of RPA operators).
[327] *CASA 1998* reg. 101.237.
[328] AC-101-10, *supra* 315.
[329] *CASA 1998* reg. 101.237.
[330] AC-101-10, *supra* 315.

> CASA's research had previously indicated that a person was likely to suffer only minor injuries if the energy level of an impact with an RPA was 69 Joules or less. At higher energy levels, the collision impact had an increased likelihood of causing severe injury or death.
> Before the release of NPRM 1309OS, CASA commissioned two research papers: one to produce an injury prediction model for the impact of small remotely piloted aircraft with a person on the ground and the second to model the potential damage to manned aircraft from a mid-air collision by a small unmanned aircraft.
> Knowing that the maximum permissible impact energy for a collision between a person and an RPA was 69 Joules, the first research paper (human injury prediction model) determined that there was only a low possibility of an RPA weighing 2 kg or less exceeding an impact energy level of 69 Joules.
> On the basis of the 2 kg weight limit identified by the first research paper, the second research paper confirmed that, for mid-air collisions with modern jet transport aircraft at landing velocities, it was unlikely that impact with an RPA weighing less than 2 kg would result in windscreen penetration."

operating conditions are defined to include visual line of sight operations, below 400 ft, subject to other operational restrictions such as prohibited areas, restricted areas and the proximity to aerodromes.[331]

Although excluded RPAs can be operated without specific authorization from CASA, the advisory circular providing guidance states that CASA should be notified prior to the commencement of an operation.[332] Hence sole traders (operators flying their own RPA), an operator employing pilots, and each pilot flying the RPA are required to give prior notice.[333] Furthermore it is required that an identification plate should be attached or identification details be written on the RPA, and should remain through-out flight time.[334]

The amendments introduced in 2016 also addresse autonomous UAVs. An express prohibition is placed on the launch or release of autonomous UAVs without prior approval and CASRs go to extent of imposing strict liability in the event of violation of that regulation.[335]

d. Critique of the regulations

Australia has clearly moved ahead in making itself better suited to host the upcoming commercial UAV industry. The simplified procedures to obtain licenses and certificates, allowing low-risk RPA operations to be conducted with no prior approval by CASA are key features indicating Australia's deregulatory approach. In contrast to several other jurisdictions which are progressing towards commercial UAV friendly regulations, Australia does not impose an age restriction on remote pilots nor does it impose mandatory insurance requirements.

Australia's relaxed approach has not gone without attracting heavy criticism by several parties. At the time of introducing the regulation, many industry components including the

331 *CASA 1998 r*eg. 101.238.
332 AC-101-10, *supra* 315.
333 *Ibid.*
334 *Ibid.*
335 *CASR 1998*, reg.101.097.

Australian Federation of Air Pilots, Australian Certified UAV Operators Inc., and private entities have raised concern as to the impact on safety due to lesser regulatory control.[336] The current regulations are criticized for "causing an unacceptable risk to the public and the industry itself."[337] The exclusion of RPAs weighing less than 2kg from obtaining RPLs and ReOC's from CASA is viewed as a factor causing further deterrence in public opinion and a major threat to safety of helicopters and small manned aircraft.[338] Compulsory training and RePLs for all pilots flying UAVs for commercial purposes and mandatory public liability insurance is advocated by critics.[339] Heeding to the safety concerns voiced by many industry stakeholders, the Australian Senate's Rural and Regional Affairs and Transport References committee, commenced an inquiry into regulatory requirements that impact safety. It was suggested by that committee, that measures are necessary to raise safety awareness and train recreational RPA pilots, to empower CASA to register and track all RPAs, and to minimize potential collisions by introducing geo-fencing technology.[340]

Despite the heavy criticism the statistics indicate growth of the UAV industry. (*See Figure 1*). CASA continues to conduct reviews of its regulations and is open to adapt according to the situation. Keeping up with the pace of technological developments is challenging for any regulator. But, with boldly embracing a progressive regulatory approach Australia has indicated its readiness to embrace the massive potential of UAVs.

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[336] See ACUO, *Submission to the Australian Senate Standing Committee on Rural and Regional Affairs and Transport, into Regulatory requirements which impact on the safe use of Remotely Piloted Aircraft Systems, Unmanned Aerial Systems and associated systems.* (24 January 2017).
[337] Andrew Chapman, "AUAV's Recommendations regarding Part 101 disallowance" (11 October 2016) online: AUAV <www.auav.com.au>.
[338] *Ibid.*
[339] *Ibid;* Perritt & Sprague *supra* note55.
[340] Austl, Commonwealth, *Senate Standing Committees on Rural and Regional Affairs and Transport Media statement*, (10 May 2017).

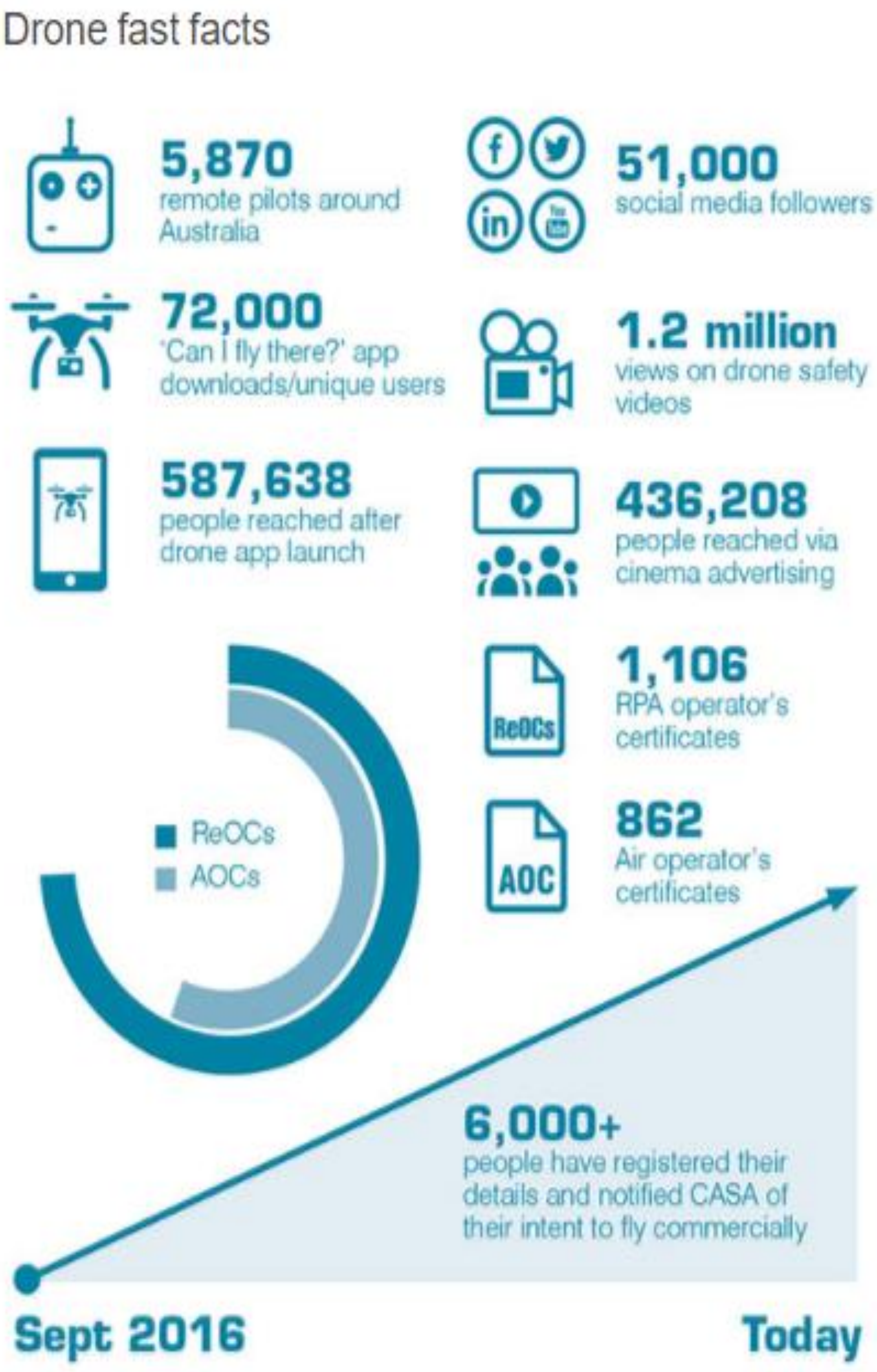

Figure 1- source: CASA <www.casa.gov.au/aircraft/standard-page/drone-safety-review>

4.3 Canada

a. Introduction

The vast and uncluttered airspace of Canada has become increasingly inviting to both recreational and non-recreational UAV operators. Canada is expected to witness a major growth in its UAV industry where much focus is placed upon "operational services such as aerial photography, surveying and inspection for a number of industries"[341] The current regulatory approach of Canada is therefore crucial to the formation of a solid UAV industry.

In Canada aviation and aeronautics are subject to the federal government's jurisdiction.[342] UAVs, which are aircraft and users of UAVs who are considered pilots,[343] are federally regulated. Civil aviation is principally governed under the *Aeronautics Act*[344] and its associated regulations, the *Canadian Aviation Regulations* (CAR).[345] Transport Canada carries out the enforcement and implementation of the regulations related to civil aviation. [346] Hence, all civil UAVs operated in the Canadian air space falls within the regulatory purview of Transport Canada.[347] It is thoroughly emphasized that in addition to the CARs and the UAV specific standards, guidelines and advisor circulars issued by Transport Canada, UAVs are obliged to follow other federal and state laws such as criminal, tort and privacy laws.[348]

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[341] *Regulations Amending the Canadian Aviation Regulations (Unmanned Aircraft Systems): Regulatory Impact Analysis Statement* (2017) C Gaz I: 151: 28. Online: Transport Canada <www.gazette.gc.ca/rp-pr/p1/2017/2017-07-15/html/reg2-eng.html>.
[342] *Constitution Act*, *1867*(UK), 30 & 31 Vict, c 3 s. 91; *Quebec (Attorney General) v. Lacombe,* [2010] SCC. 38 (Where the SC of Canada held that aeronautics was in the exclusive jurisdiction of the federal government and "falls within a residuum of national importance, which brings it under Parliament's power to legislate for the peace, order and good government of Canada.".)
[343] Transport Canada, "Notice of Proposed Amendment – Unmanned Air Vehicles", CARAC Activity Details, 2015 at 1.
[344] *Aeronautics Act*, RSC 1985, c A-2.
[345] *Canadian Aviation Regulations*, SOR/96-433. [*CAR*]
[346] Jed Chong & Nicole Sweeney, *Background Paper on Civilian Drone Use in Canada*, No. 2017-23-E (House of Commons, 2017)
[347] Patrick Vermette, "Canada" in Scott *supra* note 11. (Note that the regulation of military UAVs come under the domain of the Department of National Defence).
[348] Transport Canada "Flying your drone safely and legally" online: Transport Canada <www.tc.gc.ca>.

b. The development of regulations

The history of Canadian laws governing UAVs can be traced back to 1996, where the use of 'non-piloted aircraft' was addressed.[349] However, the term was repealed in 2003[350] and the term "unmanned air vehicle"[351] gained prominence. No person was allowed to operate an unmanned air vehicle without a special flight operations certificate (SFOC) or an air operator certificate.[352] As the public and civilian attention towards UAVs increased Transport Canada initiated efforts to update its regulations with a view to normalize civil UAV operations in Canadian airspace.[353] Working groups were formed from time to time, in collaboration with the government and the industry, to review and update UAV regulations.[354] Notably in 2014, exemptions were introduced to the requirement of obtaining a SFOC, for UAVs weighing under 2kg or weighing more than 2kg but less than 25 kg used for non-recreational purposes.[355] The purpose of adopting a permissive approach was to "make it easier for Canadian businesses to operate small UAVs."[356] But, the exemptions were granted only upon meeting a number of conditions including minimum $100,000 liability insurance coverage pertaining to the operation of the UAV, performance of a site survey to assess the suitability prior to any operation, the pilot to maintain continuous unaided visual contact with the UAV and operate the UAV at or below 300ft above ground level (AGL).[357]

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[349] Transport Canada, *UAV Systems Program Design Working Group: Phase 1 Regulatory Recommendations*, (Record released pursuant to the Access to Information Act) (2012) at 35 as cited in Shayna Gersher, "Regulating Spies in the Skies: Recommendations for Drone Rules in Canada" *IEEE Technology and Society Magazine* (Fall 2014) 22.
[350] See *Canadian Aviation Regulations*, SOR/2003-271, s. 1.
[351] See *CAR* "a power-driven aircraft, other than a model aircraft, that is designed to fly without a human operator on board; (véhicule aérien non habité)".
[352] See CAR sec. 602.41 as amended by SOR/2003-271, s. 6.
[353] Canada, Office of the Privacy Commissioner, *Drones in Canada: Will the proliferation of domestic drone use in Canada raise new concerns for privacy?* (Gatineau: Research Group,2013).
[354] For an extensive discussion on the efforts of the working groups see Shayna Gersher, *Eyes in the Sky: The Domestic Deployment of Drone Technology & Aerial Surveillance in Canada* (MA Thesis, Carleton University Faculty of Faculty of Graduate and Postdoctoral Affairs, 2014) [unpublished].
[355] AC 600-004, *supra* note 267.
[356] *Supra* note 347 at 199.
[357] AC 600-004, *supra* note 267.

The process of reviewing and update regulations pertaining to UAVs is an ongoing effort by Transport Canada. Hence, keeping up with up to date regulations is challenging. In 2016 Transport Canada proposed further amendments to the UAV regulations. [358] Amongst the proposed amendments were;

> …the removal of the regulatory distinction between recreational and non-recreational users, introducing an "unregulated" category with a threshold of 250 g or less, reducing the "very small" weight threshold to 1 kg based on a risk assessment, safety analysis and ongoing research.[359]

Consequently, UAVs where the maximum take-off weight (MTOW) was 1kg or less, and UAVs of a MTOW more than 1kg up to 25 kg were exempted from obtaining a SFOC provided that other conditions as specified by Transport Canada are met.[360]

Canada further amended its regulations in relation to recreational UAVs in 2017.[361] The 2017 amendments indicate a change in the trajectory of the Canadian UAV regulations, due to the cautionary approach instead of the previous permissive nature. The stricter regulatory approach is due to the marked increase of reported incidents involving UAVs from a mere 41 in 2014 to 148 in 2016.[362] As the reported incidents include grave situations where safety of other aircraft and people were compromised, Canada's concern is unsurprising. Recently, Transport Canada published a proposal for comprehensive amendments to the CARs relating

[358] Canadian Aviation Regulations Advisory Council (CARAC), *Activity Reporting Notice on the Notice Of Proposed Amendment (NPA): Unmanned Air Vehicles* (2015) online: Transport Canada <wwwapps.tc.gc.ca/Saf-Sec-Sur/2/NPA-APM/actr.aspx?id=17&aType=1&lang=eng>.
[359] CARAC, *Executive Summary Update to Stakeholders on Unmanned Air Vehicles,* (2016) online: <wwwapps.tc.gc.ca/Saf-Sec-Sur/2/NPA-APM/actr.aspx?id=17&aType=1&lang=eng>.
[360] AC No. 600-004, *supra* note 267.
[361] See Transport Canada, *Advisory Circular on General Safety Practices: Model Aircraft and Unmanned Air Vehicle Systems*, AC 600-002; Transport Canada, *Interim Order No. 8 Respecting the Use of Model Aircraft*, (2017) C Gaz 1: 151 -26.
[362] Interim Order No.8, *ibid*, Explanatory Note.

to UAS, calling for consultations from the public.[363] The final regulations are expected to be published in 2018. [364]

c. Current UAV regulations

As at the time of writing this thesis, regulations providing the general legal framework for the safe operation of UAVs in Canada are found in CARs,[365] Advisory Circular on Exemptions and Conditions for Unmanned Air Vehicle Systems (UAVS),[366] Advisory Circular on General Safety Practices and Unmanned Air Vehicle Systems, Interim Order respecting the use of Model Aircraft[367] and, Staff Instruction on the Review and Processing of an Application for the Operation of an Unmanned Air Vehicle System.[368]

Canadian regulations distinguish model aircraft by defining them to be "… aircraft, the total weight of which does not exceed 35 kg (77.2 pounds), that is mechanically driven or launched into flight for recreational purposes and that is not designed to carry persons or other living creatures."[369] Although model aircraft were largely excluded from the CARs and least regulated,[370] given the rising concerns due to reported UAV incidents, Transport Canada has sought to tighten its reins via the newly introduced regulations.[371] The prohibitions include the limiting the operation of model aircraft to over 300ft AGL, within controlled and restricted airspace, at night and over or within an open air assembly of people. Operations are VLOS only and the owner of the model aircraft is responsible for making contact information clearly

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363 *Supra* note 341.
364"Proposed Rules for drones in Canada" online: Transport Canada <www.tc.gc.ca/eng/civilaviation/opssvs/proposed-rules-drones-canada.html>.
365 *CAR* ss.101.01, 602.41 & 603.65-8.
366 AC No. 600-004, *supra* note 267.
367 Interim Order No.8, *supra* note 362.
368 Transport Canada, *Staff Instruction Review and Processing of an Application for a Special Flight Operations Certificate for the Operation of an Unmanned Air Vehicle (UAV) System*, SI No. 623-001, online: Transport Canada <ww.tc.gc.ca/eng/civilaviation/standards/general-recavi-uav-4161.html>.
369 *CAR*, reg. 101.01
370 AC 600-002, *supra* note 361.
371 See Interim Order no. 8, *supra* note 362 in conjunction with AC 600-002 *supra* note 362.

visible on his aircraft.[372] Violation of the regulations could result in penalties and in events such as endangering the safety of other aircraft could result in criminal liability.[373]

Unless exempted, UAVs for non-recreational purposes, are to be operated under an SFOC, issued by the Transport Minister.[374] As discussed before, due to the low risk potential, UAVs with a MTOW less than 1kg (2.2lbs) and with a MTOW exceeding 1kg (2.2lbs) but not exceeding 25kg (55lbs) are exempted from obtaining an SFOC.[375]

Transport Canada provides comprehensive instructions to its instructors, to "assess and prepare an SFOC as required by … the CARs for the safe conduct of UAVs".[376] A UAV must therefore satisfy the many requirements including steps to maintain airworthiness, collision avoidance, effective control over the UAV, constant communication and oversight and safety requirements when operating in non-segregated airspace.[377] Unlike model aircraft, it is not required for UAVs operating under a SFOC to be marked or registered.[378]

Canada does not impose separate licensing requirements for UAV owners, pilots or operators. But the Staff Instructions provide that,

> [p]ersons associated with the operation of the UAV system, responsible for taking safety related actions or making safety related decisions about the operation must be a minimum of 18 years of age.[379]

The wide-reaching provision applies to pilots, visual observers, payload operators and system managers.[380] Furthermore, pilots should be trained and pilots of UAVs weighing less than 25 kg, must be medically fit, of sound knowledge on aeronautics and Transport Canada policies.[381]

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372 *Ibid*
373 *Ibid.*
374 *CAR*, reg. 603.66
375 AC 600-004, *supra* note 267.
376 SI 623-001, *supra* note 368.
377 *Ibid.*
378 *Ibid,* s.5.2.
379 *Ibid,* s. 4.1.
380 *Ibid,* s.4.1
381 *Ibid.*

A notable feature of the Canadian regulations is mandatory liability insurance.[382] Adequate insurance covering risks of public liability is a condition of the SFOC, and it is the responsibility of the UAV operator to ensure his liability insurance applies to operation of the UAV.[383]

d. Critique of the regulations

Throughout, Canada has employed a weight and associated risk-based approach to draft regulations for UAVs. *Prima facie*, Canada remains a permissive jurisdiction for commercial UAV operations. The exemption from SFOC's granted for small UAVs has served as an encouragement to many businesses.[384] Nevertheless, to obtain the exemption, an operator is required to satisfy a lengthy list of conditions which entails several restrictions on the operation of UAVs: as UAV pilots are allowed to operate only within Class G airspace[385] and during daylight hours. Furthermore, UAV pilots are not allowed to operate over or within a built-up area[386], open-air assembly of persons or more than one UAV at a time.[387] The rationale for imposing a list of extensive conditions can be inferred by the Transport Canada guidance material, which notes that UAVs operated under exemptions do not necessarily meet technical airworthiness standards. It is not mandatory for exempted UAVs to meet communication and Air Traffic Management (ATM) equipment requirements. Therefore, the lack of assurances as to the reliability of the UAV can increase risks to persons and property on ground. [388] Imposing

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[382] *Ibid*, s. 6.31
[383] *Ibid*.
[384] See "Transport Canada Announces exemptions for UAVs" *realagriculture* online: <www.realagriculture.com/2014/11/transport-canada-announces-exemptions-uavs/> quoting Stewart Baillie, the chair of Unmanned Systems in Canada;

> "This approach will dramatically improve the ability for Canadian businesses to safely make use of this extremely capable technology while substantially reducing the time it takes to get authorization for more complex operations,"…. "Coupled with the safety awareness campaign announced two weeks ago, I believe that Canada now has one of the most effective and progressive UAV regulatory frameworks in the world.

[385] AC 600-004, *supra* note 267. (States that Class G is undesignated air space. It is uncontrolled but regulated).
[386] *Ibid*, (A Built-up area means areas with groups of buildings or dwellings including anything from small hamlets to major cities. Anything larger than a farmstead is considered a built-up area).
[387] See "Transport Canada, Exemption from sections 602.41 and 603.66 of the Canadian Aviation Regulations" online: Transport Canada <www.tc.gc.ca/civilaviation/regserv/affairs/exemptions/docs/en/2880.htm>.
[388] AC 600-004, *supra* note 267.

such extensive conditions, render the exemptions futile as the allowed operations are extremely limited.[389]

The increasing administrative burden upon the regulator to issues SFOC's and the case by case approach for granting SFOC's results in the lack of regulatory predictability. It is a key issue to be solved by Transport Canada. In order to ease and stabilize the regulatory environment Transport Canada has proposed further amendments to the regulations. The proposed amendments are to come into force in 2018.

Several, important changes are proposed in the 2018 amendments. Replacing the term model aircraft and unmanned air vehicle as currently found on the CARs with the term 'unmanned air systems' is notable.[390] Amendment to the categorization of UAVs is "proposed to mitigate the risks by requiring increasingly more stringent requirements as the weight of [UAVs] increase, as well as the areas of operation." Hence, the new UAV categorization will be as depicted in the figure below. (See figure 2).

Micro	**Very Small**	**Small (Limited)**	**Small (Complex)**	**Large/Beyond Visual Line-of-Sight (BVLOS)**
250 g or less	More than 250 g to 1 kg	More than 1 kg to 25 kg	More than 1 kg to 25 kg	More than 25 kg

Figure 2 – source: Transport Canada<www.gazette.gc.ca/rp-pr/p1/2017/2017-07-15/html/reg2-eng.html>.

[389] See generally DroneIQ "Video on why the Transport Canada UAV exemption is useless?" (10 December 2014) online: You Tube < www.youtube.com/watch?time_continue=6&v=c40gl5UKvtc>.
[390] *Supra* note 341.

As indicated in the figure 2 above, the 'small' category of UAVs weighing more than 1kg to 25 kg is further divided into two classes based on the operating environment and the complexity of the operation. Therefore, the limited operations would include UAVs used for agricultural purposes, wildlife surveys and natural resources, while complex operations would be those carried over urban areas within controlled airspace. [391] The minimum age limit for pilots of UAVs weighing more than 250g to 1kg is reduced to 14 years, as that category would mostly consist of recreational uses. For limited and complex operations conducted by small UAVs (1kg – 25kg), a pilot must be 16 years or older. The new regulations introduce a basic knowledge test for all UAV pilots and in order to carry out complex operations a pilot must hold a pilot permit that is specific to small UAVs (1kg – 25kg).[392] Notably, the necessity to hold a SFOC is eliminated in the event the UAV weighs between 250g to 25 kg and is operated within VLOS.[393]

The proposed UAV regulatory changes provide a clear indication as to Canada's attempt to ensure safety. But large-scale UAV manufacturing companies such as DJI[394] have expressed concern referring to the proposed regulations as "overly restrictive".[395] The amendments propose greater restrictions over the operation of UAVs in built-up areas, which according to DJI, actively prohibits Canadians from realizing the full economic potential of UAVs.[396] At a time where global competition to attract private investments in the UAV industry is intensifying, tightening the regulations may pose Canada as less inviting compared to other countries, seemingly opening up the air space.[397]

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[391] See Transport Canada, "Proposed rules for Drones in Canada: Overview of the proposed changes" online:<www.tc.gc.ca/eng/civilaviation/opssvs/proposed-rules-drones-canada.html>.
[392] *Supra* note 341.
[393] *Supra* note 391.
[394]Note that Chinese company DJI Inc., is the largest UAV manufacturer.
[395] DJI, Press Release, "DJI Disappointed by Draft Canadian Drone Regulations: Significant Changes Needed to Create Rules That Support Safe and Responsible Flight" (19 September 2017) online:<www.dji.com/newsroom/news/dji-disappointed-by-draft-canadian-drone-regulations>.
[396] *Ibid*.
[397] See generally House of Commons, Standing Committee on Transport, Infrastructure and Communities, *Evidence*, 42nd Parl, 1st Sess, No 850 (24 November 2016). *(*Evidence of Ian Glenn, Chief Executive Officer,

4.4 United States

a. Introduction

Historically the US have played a major role in shaping the commercial aviation industry. With the deregulation initiative in 1978,[398] the US substantially influenced regulatory approaches to aviation globally. With a highly complex and saturated air space and predictions to remain the largest end market for commercial UAVs till the year 2022; [399] the UAV regulations of the US will be instructive to many governments seeking to regulate the widespread use of UAVs.

Federally, civil aviation in the US is regulated and overseen by the Federal Aviation Administration (FAA) which carries out a plethora of functions to develop the National Airspace System (NAS)[400] whilst ensuring safety.[401] The creation of the FAA can be traced back to 1958. Where the predecessor of the FAA, the 'Federal Aviation Agency' was established under the Federal Aviation Act of 1958. [402] The Federal Aviation Act is the principal legislation governing air commerce and safety throughout the NAS.

With the promulgation of the Department of Transportation Act of 1966[403] the Federal Aviation Agency was brought under the Department of Transportation (DOT) and renamed the Federal Aviation Administration (FAA). Since then the FAA is vested with the exclusive authority to enact regulations for the governance of national air space under the Federal Aviation Act.[404]

ING Robotic Aviation Inc.*)*; House of Commons, Standing Committee on Transport, Infrastructure and Communities, *Evidence*, 42nd Parl, 1st Sess, No 850 (29 November 2016). *(*Evidence of Doug Johnson, Technology Policy, Consumer Technology Association).

[398] *Airline Deregulation Act of 1978*, Pub L No. 95-504, 92 Stat 1705 (codified as 49 USC 55 1301-1542).

[399] Interact Analysis, "Commercial Drones in 2022 – Our Predictions" online: Interact Analysis <www.interactanalysis.com/drones-market-2022-predictions/>.

[400] FAA, "Mission" online: FAA <https://www.faa.gov/about/mission/>.

> "The NAS is made up of a network of air navigation facilities, ATC facilities, airports, technology, and appropriate rules and regulations that are needed to operate the system." -

[401] *Ibid*.

[402] *Federal Aviation Act of 1958*, Pub L No 85-726, 72 Stat, 731:

[403] *Department of Transportation Act*, Pub L No 89-670, § 9, 80 Stat. 931, 944-47 (1966)

[404] See 49 USC § 40103.

FAA introduces Federal Aviation Regulations (FARs)[405] to manage the use and operation of the NAS which addresses the different facets including aircraft, air carriers, airports, air traffic management, licensing of pilots and minimum safety standards. In addition to the FARs, the regulatory framework also comprises of advisory circulars, orders, notices to airmen (NOTAM) and other supplementary documents issued by the FAA.[406]

By virtue of its statutory authority, the FAA has introduced regulations and supplementary material addressing the operation of UAVs, to facilitate its integration to the NAS. The process has been incremental due to the fact that FAA makes regulations as it acquires better understanding of operational issues and technology considerations.[407]

b. The development of regulations

At the outset it is important to stress that the US uses the term 'unmanned aerial system (UAS)[408] throughout its regulations, and the regulations are therefore based on the notion that "a UAV is not just an unmanned [aircraft], but a more complex system consisting of ground operations/pilot-in-command, communication and data links and the launch and recovery of elements as well".[409] According to the FAA, the limited use of UAS for public missions such as disaster relief, search and rescue, law enforcement, fire-fighting and research was allowed from the 1990's. [410]

The regulatory history of recreational UAS which are classified under model aircraft, can be traced back to 1981. FAA's advisory circular on 'Model Aircraft Operating Standards'

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[405] *Aeronautics and Space,* 14 CFR §§1 – 199.
[406] FAA, "Regulations & Policies" online: FAA<www.faa.gov/regulations_policies/>.
[407] FAA, "Fact Sheet – Unmanned Aircraft Systems (UAS)" (Press Release: 15 February 2015) online: FAA<www.faa.gov/news/fact_sheets/news_story.cfm?newsId=18297>.
[408] *FAA Modernization and Reform Act*, Pub L 112-095, § 331, 126 State 11(2012).[FMRA]
(The term ''unmanned aircraft system'' means an unmanned aircraft and associated elements (including communication links and the components that control the unmanned aircraft that are required for the pilot in command to operate safely and efficiently in the national airspace system.)
[409] Kaiser," Third Party Liability" *supra* note 237.
[410] *Supra* note 407.

recognized the occasional hazards posed by model aircraft and suggested a set of operational standards to be voluntarily adhered to.[411]

The increasing use of UAS for civilian uses prompted regulatory response. Though not a regulatory document,[412] the FAA issued a memorandum in 2005 providing a broad definition to 'unmanned aircraft'.[413] The memorandum barred civil UAS operators from applying for a Certificate of Waiver or Authorization (COA) but indicated the necessity to follow the airworthiness certification process at the time to operate in the NAS.[414]

In 2007, FAA issued a policy statement emphasizing that, no person was allowed to operate UAS in the NAS without specific authority.[415] FAA further clarified that "for UAS operating as public aircraft the authority is the COA, for UAS operating as civil aircraft the authority is special airworthiness certificates, and for model aircraft the authority is AC 91–57".[416] The policy was later revised in 2008 by way of the Interim Operational Approval Guidance 08-01, which provided a simplified process to be followed by civil UAS operators when obtaining a special airworthiness certificate under Title 14 of the Code of Federal Regulations (CFR).[417]

The issuing of special airworthiness certificates was extremely limited and were more often granted for educational purposes. The operation of UAS for commercial purposes was therefore highly restricted and one could say, almost prohibited.

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[411] US, FAA *Advisory Circular on Model Aircraft Operating Standards* (FAA AC 91-57).
[412] US, FAA, *Report on Unmanned Aircraft System Regulatory Review* (DOT/FAA/AR-09/7) (Springfield, Virginia: National Technical Information Service, 2009).
[413] US, FAA, *Unmanned Aircraft Systems Operations in the U.S. National Airspace System: Interim Operational Approval Guidance* (AFS-400 UAS Policy 05-01) (2005).

> "Unmanned aircraft is a device that is used or intended to be used for flight in the air that has no onboard pilot. This includes all classes of airplanes, helicopters, airships and translational lift aircraft that have no onboard pilot. A {[Unmanned Aircraft] is an aircraft as defined in 14 CFR 1.1."

[414] *Ibid.*
[415] 14 CFR part 91.
[416] *Ibid*.
[417] US, FAA, *Unmanned Aircraft Systems Operations in the U.S. National Airspace System: Interim Operational Approval Guidance* (Guidance 08-01) (2008).

However, with the heightening interest for commercial UAS operations and the increasing number of civil UAS users, the need to integrate UAS to the NAS was increasing. Hence the US Congress intervened by promulgating the Federal Aviation Administration Modernization and Reform Act (FMRA) of 2012.[418]

The FMRA directed the FAA to develop a comprehensive plan for the safe and accelerated integration of UAVs to the NAS. Furthermore, the FMRA placed an edict that the integration of UAVs to NAS should complete by not later than 30 September 2015.[419] Accordingly, the FAA presented The UAS Comprehensive Plan in November 2013 which describes the future steps of the FAA. [420] The FAA also unveiled its Roadmap for integration of Civil UAS in the NAS outlining the future policies, regulations and the timeline for development of rules. [421] Although the 2015 deadline has long passed and the integration of UAS to the NAS is not complete, the progress of regulations is undeniable.

The FMRA serves as the foundation for the development of regulations and provided definitions for 'small unmanned aircraft'[422] and 'model aircraft',[423] which is now the basis for introducing rules and regulations. Codifying the "long standing hands-off approach to regulating model aircraft,"[424] section 336 of the FMRA created a special rule for model aircraft.[425] Thereby model aircraft were excluded from being regulated under the rules made by virtue of the FMRA, as long as it operates in accordance with section 336.[426]

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[418] *FMRA* § 331.
[419] *FMRA* § 332.
[420]*Unmanned Aircraft Systems (UAS) Comprehensive Plan: A report on the nation's UAS path forward prepared by the Joint Planning and Development Office*, (FAA, 2013).
[421] *Supra* note 17.
[422] *FMRA* § 331 (6) (The term ''small unmanned aircraft'' means an unmanned aircraft weighing less than 55 lbs).
[423] *FMRA* § 336 (c) (a model aircraft is an unmanned aircraft capable of sustained flight in the atmosphere, flown within visual line of sight of the person operating the aircraft, and flown for hobby or recreational purposes)
[424] *Taylor v. Huerta,* no. 15-1495 (DC Cir 2017), Kavanaough J.
[425] *FMRA* §.336 (codified as 14 CFR part 101); *ibid* (The court of Appeal of Columbia decided that the FAA could not call for registration of Model Aircraft).
[426] *Ibid*

UAS operations conducted for purposes other than recreational purposes, were subject to the several regulations including 49 USC and 14 CFR, in order to receive authorization to operate in the NAS. The FMRA somewhat widened the scope for commercial UAS operators by providing the authority to the Secretary of Transport, to grant exemptions from operating rules and to authorize the operation of low risk UAS in the NAS, prior to the implementation of rules for small UAS.[427]

c. Development of regulations after the FMRA

The FMRA's promulgation led to several applications for exemptions by commercial UAS users,[428] primarily in the real estate, film making, oil and gas, and agricultural industries.[429] In February 2015 the FAA published a Small UAS Notice of Proposed Rule Making (NPRM)[430] to establish a "framework of regulation that would allow the routine use of small UAS [for non-recreational or non-hobby purposes] while maintaining flexibility to accommodate future technological innovations."[431] Based on the responses to the NPRM the FAA developed the small UAS rule, referred to as Part 107 which came into effect in August 2016.[432]

Part 107 applies to unmanned aircraft weighing less than 55 lbs (25 kg) and does not apply to model aircraft operated in accordance with section 336 of the FMRA.[433] Marking a milestone in the UAS integration plan, part 107 enables the operation of small UAS for non-recreational purposes without an airworthiness certificate or an exemption.[434] However, meeting the operational limits, aircraft requirements and operator responsibilities to fly under

[427] *FMRA* § 333
[428] *Supra* note 407.
[429] Danielle Lucey & Brett Davis eds, T*he First 1,000 commercial UAS Exemptions,* (AUVSI, 2015).
[430] US, FAA, *Operation and Certification of Small Unmanned Aircraft Systems*, 80 FR 9544.
[431] FAA, Press Release, "DOT and FAA Propose New Rules for Small Unmanned Aircraft Systems" (15 February 2015).
[432] 14 CFR Part 107
[433] 14 CFR Part 101; *FMRA*
[434] 14 CFR § 107.1

the small UAS rule, is no walk in the park for the UAS operator. Amongst the many limitations of Part 107 it is noteworthy that only VLOS operations, conducted during day-light are allowed. Flying over persons not directly involved in the operation is prohibited. Maximum altitude to conduct operations is 400 ft AGL or above 400 ft of a structure. Operations from a moving vehicle is prohibited unless in a sparsely populated area.[435] No operations are allowed in the vicinity of airports, in prohibited and restricted areas.

In order to become a UAS pilot, the minimum age requirement of 16 years must be fulfilled and be vetted by the Transport Security Agency. It is mandatory to pass an initial aeronautical knowledge test held by a FAA approved centre and obtain a remote pilot certification with small UAS rating.[436] Additionally, pilots are required to undergo recurrent aeronautical tests every 24 months.[437]

As for the aircraft, though no airworthiness certification is required, the remote pilot in command is obligated to conduct a pre-flight test, to ensure the safety of the aircraft.[438] Part 107 vests the responsibility of assessing the environment on the remote pilot before flying, to ensure safety to persons and property in the vicinity.[439]

Recognizing the numerous practical applications of autonomous UAS operations and its significance to the industry, FAA's small UAS rule allows limited autonomous operations. The condition for operating autonomous unmanned aircraft is that the "remote pilot in command must retain the ability to direct the small unmanned aircraft to ensure compliance with the requirements of part 107."[440]

To operate under Part 107, a small unmanned aircraft must be registered as provided for in 14 CFR part 47 or part 48. The registration requirement applies to both recreational and

[435] 14 CFR §§ 107.11-107.51.
[436] 14 CFR §§ 107.52-107.79.
[437] *Ibid.*
[438] 14 CFR § 107.19.
[439] 14 CFR § 107.49.
[440] *Ibid.*

non- recreational aircraft. It is important to note that, in December 2015 the FAA issued an interim final rule which requires the registration of UAS weighing more than 0.55 lbs and less than 55 lbs. [441] Notwithstanding the statutory prohibition on regulating model aircraft under the FMRA, FAA continued to register model aircraft. The rule was challenged in the case of *Taylor v. Huearta*, where the Federal court decided that that the "registration rule is unlawful to the extent that it applies to model aircraft."[442] Although recreational UAS users or the hobbyists enjoyed the liberty of flying without prior registration for a short period, the rule to register was restored under the *National Defense Authorization Act 2018*.[443] Hence, as it stands today, it is mandatory that all UAS operators register with the FAA prior to conducting any outdoor activity.

In 2016, the US took further legislative action to address the numerous safety concerns arising due to the integration of UAS to the NAS, by promulgating the *FAA Extension, Safety, and Security Act of 2016*.[444] It requires manufacturers to provide a statement of safety of the aircraft to the owner, at the time of delivery. Furthermore, the FAA is directed to collaborate with industry stakeholders to develop consensus standards, and to coordinate with other government agencies such as the National Aeronautics and Space Administration (NASA), to facilitate the integration process.[445]

As early as 2015, President Obama issued a presidential memorandum encouraging a process involving multi-stakeholders to develop practices addressing privacy, accountability and transparency issues raised due to private and commercial UAS in the NAS.[446] Heeding to the memorandum, the National Telecommunications and Information Administration (NTIA)

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[441] 14 CFR part 48.
[442] *Taylor v. Huerta, supra* note 424.
[443] *National Defense Authorization Act of 2018*, Pub L No 115-91, § 336.
[444] *FAA Extension, Safety, and Security Act of 2016,* Pub L No 114-190, 130 Stat 631.
[445] *Ibid*
[446] Presidential Memorandum from Office of the Press Secretary, White House, (15 February 2015), online: <obamawhitehouse.archives.gov/>. (Promoting Economic Competitiveness while Safeguarding Privacy, Civil Rights, and Civil Liberties in Domestic Use of Unmanned Aircraft Systems).

presented a set of voluntary best practices, compiled as a result of a multi-stake holder initiative.[447] The best practices primarily cover the collection, dissemination and securing data and information by UAS.[448]

The best practices do not carry the weightage of regulations. Nevertheless, it is an important step towards garnering public acceptance, which is crucial for the successful integration of UAS to NAS.

d. Critique of the regulations

By examining the progression of US regulations, it becomes evident that the regulators are gradually removing the red tape surrounding UAS operations. The process has been slow and lagging far behind the timeline initially envisaged by the FAA Roadmap.[449] The delay in regulations have created several impediments to realizing commercial ventures as planned. Frustrated companies have relocated their pilot projects to other countries and considerably delayed business operations.[450]

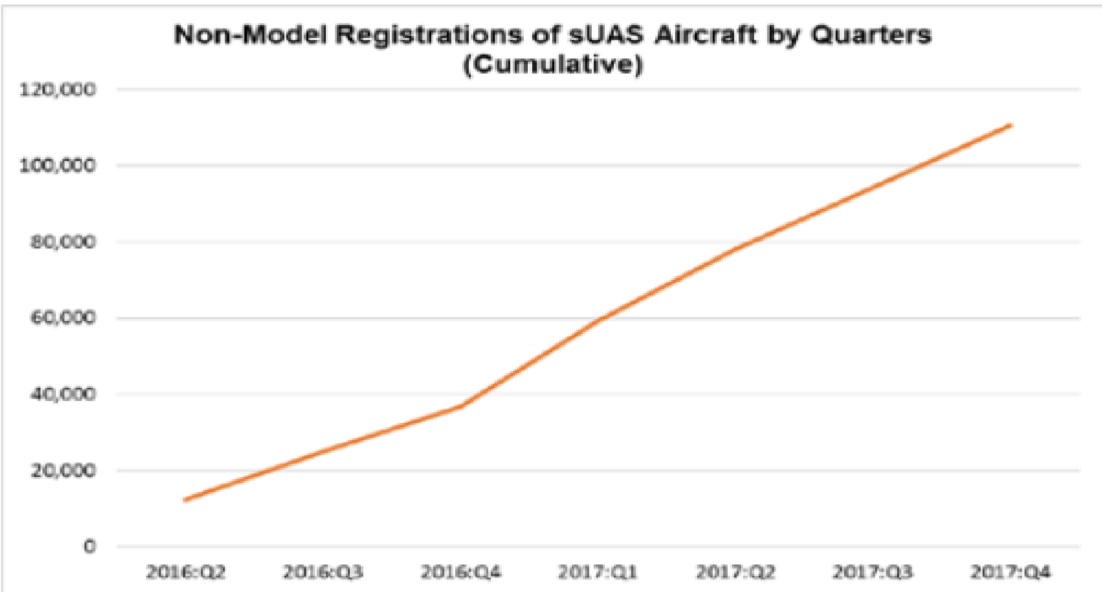
Currently the FAA is more accepting of commercial UAS ventures and Part 107 has substantially supported the growth of commercial users. According to the estimates of the FAA, the small non-model UAS fleet is expected to grow from 110,604 in 2017 to 451,800 in 2022.[451] However, the many limitations including the prohibitions on BVLOS operations, flying during night time, operating UAVs from moving vehicles and the prohibition on flying a UAV over

447 US National Telecommunications and Information Administration (NTIA), *Voluntary Best Practices for UAS Privacy, Transparency and Accountability* (online: NTIA, <www.ntia.doc.gov/files/ntia/publications /voluntary_best_practices_for_uas_privacy_transparency_and_accountability_0.pdf>.
448 *Ibid*.
449 *Supra* note 17.
450 David Pogue, "Exclusive: Amazon reveals Details About Its Crazy Drone Delivery Program" *Yahoo Finance* (16 January 2016), online: <finance.yahoo.com/news/exclusive-amazon-reveals-details-about-1343951725436982.html?src=rss>; April Glaser, "Why Amazon is testing drone delivery in the UK and not in the US" *Recode* (16 December 2016) online: <www.recode.net/>.
451 FAA, *Aerospace Forecast Report: Fiscal years 2018 – 2038* (FAA, 2018).

any person not directly involved with the operation, pose severe barriers to the expansion of commercial UAV operations.

A prominent shortcoming in the US regulations, is that it attempts to encompass an extremely broad range of UAVs under the final small UAS rule. No special freedoms are afforded to light weight micro UAVs which pose a considerably low risk to people and property. The strict regulations are therefore overly burdensome and unnecessary. Although the NPRM published prior to issuing Part 107 proposed a less strict set of regulations for micro UAS, it did not come into fruition, due to the conflicting views of stakeholders. The FAA then decided that a separate rule is called for micro UAS.[452] It would definitely be a welcome step for the US FAA to introduce less restrictive regulations for micro UAS.

Although the discussion in this thesis is confined to the federal regulations and the NAS, the UAS operators in the US constantly grapple with the problem of conflicting state and local laws. Achieving harmony between all state legislation concerning UAS is a behemoth task, but necessary in order to carry out commercial operations such as inter-state delivery.



[452] Preamble to the *Operation and Certification of small UAS*, 81 Fed Reg 42063 (2016).

Figure 3 source: FAA:<www.faa.gov/data_research/aviation/aerospace_forecasts/media/FY2018-38_FAA_Aerospace_Forecast.pdf> (shows how the commercial UAS users have accelerated after the Small UAS rule).

However, the nascent UAS industry can remain hopeful. As it is enumerated in the current policy of the US, the objective is "to promote the safe operation of UAS and enable the development of UAS technologies for use in agriculture, commerce, emergency management, human transportation, and other sectors."[453] As stated by White House's Chief Technology Advisor Michael Kratsios, the US is committed to fostering innovation by not allowing the "the promise of tomorrow to be hamstrung by the bureaucracy of the past." [454]

4.5 European Union (EU)

a. Introduction

With increased automation in civil aviation, EU acknowledges the vitality of UAVs to keep itself ahead in the competitive aviation industry.[455] Recent estimates state that UAVs will create over 100,000 jobs and have an economic impact of € 10 billion in Europe, within 20 years.[456] Originally, the European Aviation Safety Agency (EASA) regulated unmanned aircraft with an operating mass over 150kg by virtue of the mandate granted under Regulation 216/2008.[457] Despite the lack of a comprehensive EU level regulation addressing the operation of smaller UAVs, member States have strived to close the gap by introducing, national level regulations.

[453] Presidential Memorandum for the Secretary of Transportation on Unmanned Aircraft Systems Integration Pilot Program (31 October 2017) online: DOT <www.transportation.gov/briefing-room/presidential-memorandum-secretary-transportation>.
[454] Michael Kratsios (Address delivered at the 2018 FAA UAS Symposium) cited in Marco Margartoff "The FAA Projects Fourfold Increase in Commercial Drones by 2022" *The Drive* (19 March 2018) online: <www.thedrive.com/>.
[455] European Commission, "Unmanned Aircraft: Growth" online: EU <ec.europa.eu/growth/sectors/aeronautics/rpas_en>.
[456] *Ibid.*
[457] *EC, Commission Regulation (EC) 216/2008 of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC,* [2008] OJ, L 79/1.

France for example, was one of the first countries in the world to introduce UAV specific regulation by way of two Ministerial Orders in April 2012.[458] The 2012, ministerial orders were repealed and replaced by two Ministerial Orders in 2015 concerning pilots of UAVs and the use of national airspace by UAVs.[459] The current regulations in France categorize UAVs into three sectors viz, hobby and competition flying, flying for testing or experimental purposes and particular activities which primarily represents commercial UA operations. France places several limitations such as day-time flights only,[460] VLOS operations,[461] prohibition of flight over public areas located within a city and over areas near aerodromes.[462] Certain UAVs operated under the 'particular activities' category, require certification of design (attestation de conception) in order to be flown. The granting of a certification of design is contingent upon the UAV design satisfying safety requirements.[463]

The French authorities have been generous in granting special authorization for operating UAVs over populated areas and even beyond the pilot's line of sight.[464] Recently it was reported that France proposes to make it compulsory for UAVs weighing 800g or more to install electronic beacons.[465] The progressive steps suggest France may soon allow beyond day-time and BVLOS operations. .

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[458] France, *Arrêté Relatif à la conception des aéronefs civils qui circulent sans aucune personne à bord, aux conditions de leur emploi et sur les capacités requises des personnes qui les utilisent*, (11 April 2012).

[459] France, A*rrêté, Relatif à la conception des aéronefs civils qui circulent sans personne à bord, aux conditions de leur emploi et aux capacités requises des personnes qui les utilisent* (Order on the design of unmanned civil aircraft, the conditions of use and required capabilities of the people who use them). (17 December 2015) [First 2015 Ministerial Order]; France, *Arrêté Relatif à l'utilisation de l'espace aérien par les aéronefs qui circulent sans personne à bord* (Order on the use of airspace by unmanned aircraft). (17 December 2015) [Second 2015 Ministerial Order]

[460] Second 2015 Ministerial Order, art. 3(4)

[461] Second 2015 Ministerial Order, art 2(2).

[462] Second 2015 Ministerial Order, art 5(1).

[463] First 2015 Ministerial Order, art. 2.1(1).

[464] See e.g. Delair "1st in France: Drone completes 30 miles BVLOS flight via 3G network" (8 June 2017) *Delair* (blog), online: <delair.aero/drone-completes-bvlos-flight-via-3g/>; Thomas Leclerc, "France" in Scott *supra* note 11 at 225.

[465] *Ministère de l'intérieur Ministère de l'économie et des finances & Ministère de la transition écologique et solidaire Transport, "Arrêté définissant les caractéristiques techniques des dispositifs de signalement électronique et lumineux des aéronefs circulant sans personne à bord*" online: FFAM <newsletter.ffam.asso.fr/nwlt/fichiers/projet-arrete-signalement.pdf>. on the requirement of having electronic beaon attached to the unmanned aerial vehicles)

Italy initiated the regulating of UAVs when the Italian Civil Aviation Authority (ENAC) issued a regulation addressing remotely piloted aerial vehicles in 2013.[466] Accordingly, RPAS denotes RPAs not used for recreational purposes whereas model aircraft include RPAs used exclusively for recreational or sport purposes.[467]RPAs with a MTOW below 25kg and engaged in non-critical operations can be flown under a declaration as to its airworthiness made by the operator. RPAs engaged in critical operations require authorization from ENAC.[468] For RPAs equal or exceeding 25kg in MTOW it is mandatory to obtain the airworthiness certification and authorization from ENAC.[469]

Spain currently regulates UAV activities byway of the *Real Decreto 1036/2017* (Royal Decree 1036/2017)[470] which is premised upon the concept that only remotely piloted unmanned aircraft (RPA) can be integrated to the non-segregated airspace and be allowed to operate with the rest of manned aircraft. Although the regulation effectively shuts out autonomous UAV operations, in principle Spain allows extended visual line of sight operations (EVLOS) and BVLOS operations for RPAs. The prior requirements to be fulfilled in order to conduct BVLOS operations, is less arduous compared to many countries.[471] Italy is party to the Rome Convention of 1952[472] modified by the Montreal Protocol of 1978,[473] and due to the applicability of the *Italian Navigation Code* upon RPAs[474] it is deemed that RPAs are subject

[466] Italy, ENAC, *Regolamento Mezzi Aerei a Pilotaggio Remoto*[Remote Pilot Vehicles Regulation], Edition No.2, Amendment 1(21 December 2015).
[467] *Ibid*.
[468] *Ibid* ; Federico Bergamsco, "Italy" in Scott *supra* note 11 at 252. (Non criticial operations are those performed in VLOS subject to conditions of overflying congested, urban areas or critical infrastructure. Critical operations do not conform to the conditions).
[469] *Ibid*.
[470] Spain, *Real Decreto 1036/2017* [Royal Decree 1036/2017] (15 December 2017) (regulates the civil use of piloted aircraft by remote control).
[471] *Ibid*.
[472] Convention on Damage Caused by Foreign Aircraft to Third Parties on the Surface, 7 October 1952, 310 UNTS 181 (entered into force on 4 February 1958). [*Rome Convention*]
[473] *Protocol to amend the Rome Convention* (ICAO Doc 9257).
[474] Italy, *Codice della Navigazione* [Code of Navigation], approvato con R.D. 30 marzo 1942, n. 327) Parte aggiornata al decreto legislativo 15 marzo 2006, n. 151, § 965 provides for the direct applicability of international law to damage caused to persons or property on the surface by an aircraft registered in Italy within Italian territory).

to liability provisions of the Convention. Minimum third-party insurance coverage is mandatory for RPAs under the Italian regulation.

Apart from a handful, majority of the EU member states have already introduced UAV specific rules and regulations within their respective territories. However as indicated in the examples discussed above, the "extent, content and level of details of the rules differ."[475] Although common traits such as weight-based categorization, distinction between recreational and non-recreational users, over-flight prohibitions, safety requirements and operational limits exist in every national body of regulations, the disparities are many. EU member States have not agreed upon conditions for mutual recognition either.[476] The fragmented regulations do not provide stability to the UAVs planned to be operated under a single European sky.[477] To avoid legal uncertainty and to ensure the development of a competitive UAV industry, a clear European legal framework is urgent as inaction would thwart the realization of the full economic potential of UAVs.[478]

b. The EU initiative

The European Union is currently working towards introducing a comprehensive regulatory framework for civil UAV operations within Europe. The task of developing new regulation to harmonize EU-wide use of UAVs, is vested upon the European Aviation Safety Agency (EASA).[479] The early documents uses the term RPAS[480] and in 2012 the European Commission established a RPAS steering group for planning EU's work to develop

[475] Maria Juul, E*uropean Parliament Briefing Civil Drones in the European Union* (EPRS, 2015) online: <www.europarl.europa.eu/RegData/etudes/BRIE/2015/571305/EPRS_BRI(2015)571305_EN.pdf>.
[476] *Ibid.*
[477] Sarah Jane Fox, The Rise of the Drones: Framework and Governance - Why Risk It, 82 J. Air L. & Com. 683 (2017).
[478] European Parliament, *Report on safe Use of Remotely Piloted Aircraft Systems (RPAS), Commonly known as Unmanned Aerial Vehicles (UAVs), in the Field of Civil Aviation,* (EP 2014/2243) (EU Parliament, 2015).
[479] *Regulation No 216/2008, supra* note 457.
[480] EC, *Staff Working Documents Towards a European strategy for the development of civil applications of Remotely Piloted Aircraft Systems*, SWD(2012) 259; EC, *Conclusions of the European Council* (2013) EUCO 217/13.

regulations.[481] The steering group's findings and recommendations were presented in a form of roadmap aiming an initial integration of RAPS by 2016.[482] At a time the demand for civil UAVs was swiftly ascending, the Commission adopted a Communication to lay out its strategy for integration of RPAS to the European sky in a safe and sustainable manner.[483]

Paying heed to the societal impacts of RPAS, the Commission indicated a "step-by-step approach, by firstly regulating… operations with mature technologies. More complex operations would be permitted progressively, [with the long-term objective of integrating] RPAS in non-segregated airspace which is open to all civil air transport."[484]

Subsequently, the EU community agreed to the guiding principles in its UAV regulations at a conference held in Riga in 2015.[485] In the Riga Declaration, it was agreed *inter alia*, that regulations should be proportionate to the risk posed by UAVs, privacy and protection of personal data and safety should be a priority, and the operator of a UAV should be identifiable and responsible for the operation.[486]

Following the Riga Declaration, EASA undertook the task of developing an EU level regulatory framework for civil UAVs.[487] EASA's initially developed proposals for "an operation centric, proportionate, risk-and performance based regulatory framework for all unmanned aircraft."[488] Consequently, EASA published a Notice of Proposed Amendment

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481 SWD (2012) 259, *Ibid*.
482 *Roadmap for the integration of civil Remotely-Piloted Aircraft Systems into the European Aviation System* (European RPAS Steering Group, 2013).
483 EC, *Communication from to the European Parliament and the Council: A new era for aviation -opening the aviation market to the civil use of remotely piloted aircraft systems in a safe and sustainable manner*, COM (2014) 20il.
484 *Supra* note 475.
485 EC, *Riga Declaration on Remotely Piloted Aircraft (drones): Framing the future of Aviation* (Riga: 2015) online: EU< ec.europa.eu/transport/sites/transport/files/modes/air/news/doc/2015-03-06-drones/2015-03-06-riga-declaration-drones.pdf>.
486 *Ibid.*
487 Arthur P. Cracknell "UAVs: regulations and law enforcement" (2017) 38:8-10 International Journal of Remote Sensing 3054-3067.
488 EASA, "Drones-regulatory framework background" online: EASA <https://www.easa.europa.eu>.

(NPA)[489] suggesting three categories of UAVs based on the operations, namely open[490], specific[491] and certified.[492] Opting for the wider term 'drone'[493] the NPA lists out different regulatory standards for the three categories. Upon receipt of stakeholder comments and consultations, EASA publishes prototype regulation for open and specific categories.[494] Developing regulations for the open and specific categories was prioritized by the EASA due to the market needs.[495] The prototype regulation uses the term UAS denoting the "unmanned aircraft and any equipment, apparatus, appurtenance, software or accessory that is necessary for the safe operation of the unmanned aircraft."[496] The prototype provides a variety of regulations including rules for the operating requirements, flight conditions, technical and safety functions of aircraft and competencies of operators.

The EU has constantly highlighted its interest in providing a sound regulatory foundation for the development of the UAS industry and reiterated its commitment by way of the Warsaw Declaration in 2016.[497] In May 2017, EASA published NPA 2017-05 proposing to extend the competence of the EU to regulate UAS regardless of their MTOW and thereby replace the Basic Regulation 216/2008.[498] The proposal for the new Basic Regulation was further complimented by an impact assessment.[499]

[489] EASA, *Introduction of a regulatory framework for the operation of drones*, A-NPA 2015-10.
[490] *Ibid* - 'Open' category (low risk): safety is ensured through operational limitations, compliance with industry standards, requirements on certain functionalities, and a minimum set of operational rules. Enforcement shall be ensured by the police.
[491] *Ibid* - Specific operation' category (medium risk): Authorization by National Aviation Authorities (NAAs), possibly assisted by a Qualified Entity (QE) following a risk assessment performed by the operator. A manual of operations shall list the risk mitigation measures
[492] *Ibid* - Certified' category (higher risk): requirements comparable to manned aviation requirements. Oversight by NAAs (issue of licences and approval of maintenance, operations, training, Air Traffic Management (ATM)/Air Navigation Services (ANS) and aerodrome organisations) and by EASA (design and approval of foreign organisations).
[493] *Ibid – Defined drone* - 'Drone shall mean an aircraft without a human pilot on board, whose flight is controlled either autonomously or under the remote control of a pilot on the ground or in another vehicle.' -
[494] EASA, '*Prototype' Commission Regulation on Unmanned Aircraft Operations* (EASA, 2016)
[495] EASA, "Drones-regulatory framework background" *supra* note 489.
[496] *Ibid* art. 2.
[497] EC, *Warsaw Declaration on Drones as a leverage for jobs and new business opportunities* (Warsaw:2016).
[498] EASA, *Introduction of a regulatory framework for the operation of drones: Unmanned aircraft system operation in the open and specific category,* NPA 2017-05 (A).
[499] EASA, *Introduction of a regulatory framework for the operation of drones: Unmanned aircraft system operation in the open and specific category,* NPA 2017-05 (B).

The said impact assessment revealed that, due to the EU market requirements to conduct cross border operations, emerging new actors in aviation and the rapidly changing technology lead to serious issues that requires regulatory attention. The issues included, the lack of clarity in UAS categorizations, lack of protection of sensitive areas, inadequate technical requirements and incompetent remote pilots. The consequences of such issues lead to increased risks of accidents and collisions, violation of privacy and barriers to enter the market.[500]

The new Basic Regulation was politically agreed to by the European Council, Commission and the Parliament extending EASA's mandate to regulate UAS weighing less than 150kg.[501] Accordingly EASA published Opinion No. 01 /2018, "creating a new regulatory framework that defines measure to mitigate the risks" of operations of open and specific categories. [502] As indicated in the Opinion 'open' category will denote operations conducted with a UAS weighing less than 25kg, below 120m in height and in VLOS. Whereas 'specific' category applies to all UAS operations conducted in non-conformity to the limitations of the open category. The new regulatory framework will allow Member States to define restricted or prohibited areas within their airspace based in safety, security, privacy or environmental reasons. It is opined that UAs with a MTOM over 250g needs to be registered. Member States are responsible for the registration of UAS and will appoint a competent authority for the said purpose. Similarly, the minimum age limits for remote pilots is left to the discretion of member States.[503]

The new European regulatory framework follows a co-regulatory approach to introduce several regulations. Especially model aircraft which come within the scope of the Opinion as

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[500] *Ibid*

[501] European Council, Press Release, "Updated aviation safety rules and new rules on drones approved by the Council" (22 December 2017).

[502] EASA, *Introduction of a regulatory framework for the operation of unmanned aircraft systems in the 'open' and 'specific' categories,* Opinion 01/2018. [Opinion 01/2018].

[503] *Ibid.*

it is defined to be an unmanned aircraft under the new Basic Regulation.[504] Upon the presumption that model aircraft operated under clubs and associations adhere to a high safety culture and are less risky, the new regulations will allow "competent authorities to issue an operational authorization to model aircraft clubs and association."[505] The regulation is expected to be published in 2018, taking the EU closer to achieving its goal of a 'drone ecosystem' by 2019.[506]

c. Critique of the EU initiative

The lack of uniform and harmonized regulations in Europe is a major drawback to the industry. A single European sky and a market for UAVs would undoubtedly drive economic growth, create more jobs and improve connectivity. It would also assist achieving the bigger goals of de-carbonization and digitization under the EU aviation strategy.[507] The EU therefore, constantly encourages research and development efforts to enable complete integration of UAVs to the non-segregated airspace. Creation of U-Space is notable.[508] Given the prematurity,

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[504] *Ibid.*
[505] *Ibid.*
[506] Vincente de Frutos Christobal, *Presentation on Creating an EU Drone Ecosystem by 2019 at* Brussels 6 April 2017.
[507] Koen De Vos "Drones: Digitization and decarbonization" in EASA, "EASA's Drone Rule Proposals: Part 1" (5 July 2017) online: You Tube <www.youtube.com/watch?v=H7B10eMZNLw>.
[508] SESAR, "Joint Undertaking" online: <www.sesarju.eu/U-Space>.

> U-space is a set of new services relying on a high level of digitalisation and automation of functions and specific procedures designed to support safe, efficient and secure access to airspace for large numbers of drones. As such, U-space is an enabling framework designed to facilitate any kind of routine mission, in all classes of airspace and all types of environment - even the most congested - while addressing an appropriate interface with manned aviation and air traffic control. In support of this initiative, in 2017 the SESAR Joint Undertaking drafted the U-space blueprint, a vision of how to make U-space operationally possible. The blueprint proposes the implementation of 4 sets of services to support the EU aviation strategy and regulatory framework on drones:
>
> U1: U-space foundation services covering e-registration, e-identification and geofencing.
> U2: U-space initial services for drone operations management, including flight planning, flight approval, tracking, and interfacing with conventional air traffic control.
> U3: U-space advanced services supporting more complex operations in dense areas such as assistance for conflict detection and automated detect and avoid functionalities.
> U4: U-space full services, offering very high levels of automation, connectivity and digitalisation for both the drone and the U-space system.

EASA has refrained from including regulations to satisfy U-space requirements in its Opinion 01/2018. [509]

The Opinion 01/2018 clearly demonstrates EASA's efforts to increase collaboration amongst the public and private sectors to bring about efficient regulations. The co-regulatory approach provides the regulatory bodies with ample resources to draft well rounded regulations which address industry interests as well as safety and security concerns. The EU is well positioned to introduce trailblazing regulations, as it can consider the many regulations already introduced by different countries and with the progression of EASA's efforts one can remain hopeful as to a stable and well-coordinated regulatory framework for Europe in the near future.

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[509] Opinion 01/2018.

5. THE BEST WAY FORWARD

5.1 Introduction

States exercising their sovereignty over territorial airspace,[510] have introduced regulation to control and manage UAVs, and to prevent disturbances to the well-established aviation safety culture. The examination of regulations in Australia, Canada, United States and Europe provide an insight as to how governments and civil aviation authorities approach and tackle the fast-developing UAVs. In every regulatory framework, a cohort of common, fundamental characteristics are present as well as some differences. The differences are mostly due to the different administrative standards, the level of technology and resources available to the regulatory authority, and policy concerns. Some unique features highlighted below, are instructive to regulators engaged in rule/law making for UAVs.

5.2 Discussion and analysis

As emphasized throughout this thesis, the UAV industry is still at its early stages and steadily advancing in terms of technology. Similarly, the regulations itself are young and grappling with the numerous legal, social and ethical issues raised and anticipated. The development of regulations is largely based on the outcome of research into public opinion, economic and social benefits, associated risks and dangers, stakeholder concerns and national policies.

When examining the progression of regulations, it seems that at the early stages, regulators were more focused on deterring the arbitrary flying of UAVs to ensure safety. Given the controversial history of unmanned aviation and the ensuing negativity amongst the public, it is no surprise that the early regulations were aiming to prohibit UAV operations. The regulatory history of UAVs in the United States is an example for the initial, highly restrictive

[510] *Chicago Convention*, art. 1.

nature of regulations. Even to date, overall, the regulations do not provide the required level of lenience for commercial UAV operations to flourish.

The regulatory framework of the different States demonstrate several common characteristics. As the primary purpose of regulating UAVs is to ensure safety, the many restrictions such as prohibiting or limiting the operation of UAVs in specific areas, prohibiting dangerous or reckless flight over people and property, restrictions against flying over aerodromes, yielding right of way to manned aircraft, determining a maximum altitude for UAV operations and standards for remote pilots are present in every jurisdiction.

Generally, UAVs are categorized according to its MTOW. Canada's proposed regulations are unique, as it provides a comprehensive classification which takes both weight and the associated risks into consideration.[511] As the weight of the UAV increases, the requirements become more stringent. For example, in the very small UAVs class (250g-1kg), the minimum age of pilot is 14 years, the aircraft must be marked with name and contact information, must be flown 30m away from people and 5.5km away from airport. But for small UAVs (1kg -25kg) engaged in operations in urban areas, the pilot must be at least 16 years of age and hold a pilot permit. The aircraft must be registered with Transport Canada, meet design standards and follow flight rules. The demarcation of basic and the complex operations within the same weight class (1kg – 25kg), relieves the unsophisticated, small scale operations from going through the hassle of meeting stringent requirements. But for entities anticipating urban operations, proposed amendments do not provide comfort.[512]

The distinction between recreational and non-recreational aircraft is fundamental to initiate the process of developing regulations. Recreational or UAVs flown for fun, are generally exempt from the many stringent requirements applicable to commercial UAVs, such

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[511] *Supra* note 341.
[512] *Ibid.*

as registration of aircraft, licensing and knowledge testing of remote pilots and special approvals to conduct operations. But, an interesting pattern can be identified as the progression of regulations indicate a waning of confidence of the regulators in hobbyist UAVs. The US has consciously lessened its restrictions over UAVs allowing commercial growth.[513] By enabling exemptions under section 333 of the FMRA, US FAA first lessened the burden of obtaining a special airworthiness certificate for commercial UAVs.[514] And with the introduction of the small UAS rule, US considerably relaxed its restrictions over commercial UAVs and increased access to the NAS.[515] However, the US FAA, acknowledging the increasing hazards posed to manned aircraft in flight and to persons and property on ground, reinstated the registration requirement in order to keep tab over hobbyist UAVs.[516]

Canada tightened its reins over recreational UAVs with the introduction of the Interim Order No. 8 as a precaution to the rising number of UAV incidents.[517] For the commercial UAVs, Canada relaxed the initially imposed the rigid requirement of a SFOC to operate in Canadian airspace, by granting exemptions to low risk commercial UAVs.[518] A similar pattern can be traced in the Australian regulations which introduces excluded RPAs that reduced the regulatory requirements for flying small RPAs commercially.[519] On the contrary, “stronger and clearer” rules were introduced to govern recreational UAVs in 2017.[520]

Despite the efforts by States to adopt a more affable approach, commercial UAV operations are still severely restricted due to regulatory limitations.[521] A primary obstacle is the limitation on UAVs to operate VLOS only, which is prominent in the US, Australian and

[513] 14 CFR part 107.
[514] For a list of exemptions granted under FMRA §333 see FAA, “Authorizations granted via section 333 exemptions” online: FAA <www.faa.gov/uas/beyond_the_basics/section_333/333_authorizations/>.
[515] 14 CFR part 107.
[516] *National Defense Authorization Act 2018 supra* note 443.
[517] Interim Order no. 8, *supra* note 362.
[518] AC 600-004, *supra* note 267.
[519] *CAR* 101.237.
[520] CASA, “Flying drones or model aircraft recreationally” online: CASA<www.casa.gov.au/modelaircraft>.
[521] Therese Jones, *International Commercial Drone Regulation and Drone Delivery Services* (Santa Monica, CA: RAND Corporation, 2017).

Canadian regulations. Canada authorizes BVLOS operations on a case-by-case basis, through the SFOC applications and has so far followed a relatively permissive stance.[522] Australia permits the flying of UAVs in EVLOS if both operators and remote pilots obtain CASA approval. BVLOS operations are permitted only if the applicant demonstrates a safety level equivalent to manned aircraft operation. The evaluation is carried out under extensive criteria as listed in AC 101-01 on RPAS.[523]

In comparison, the US is the most difficult country to obtain a waiver from the VLOS rule, due to the FAA's overly cautious approach regarding BVLOS operations.[524] The EU places BVLOS operations in the 'specific' category of its proposed regulations,[525] and plans on establishing standard scenarios such as "linear inspections conducted in BVLOS" to ease the regulatory process.[526] The limitations on conducting BVLOS operations is the major impediment to the commercial UAV ventures and especially for the highly anticipated UAV delivery operations.[527] Adding to the complexities against commercial UAVs are the restrictions on operating UAVs from moving vehicles.[528] Furthermore, the US's prohibition on flying UAVs over parties not directly involved in the operation,[529] limits commercial UAV operations to remote and unpopulated areas.[530]

Governments are aware of the difficulties faced by commercial UAV operators, but reluctant to welcome commercial operations with wide arms due to numerous safety, security

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522 *Supra* note 341.
523 AC 101-01, *supra* note 539 §5.2.2
524 Dr. Allison Ferguson, "Opening the skies to beyond visual line of sight UAV operations" (May 2018) online: Precision Hawk<www.precisionhawk.com/beyond-visual-line-of-sight-bvlos-drone-operations/>. (Precision Hawk is a founding member of the "Path finder" project initiated by the US FAA to conduct BVLOS safety research. It is stated in the article that "to date, more than twelve hundred BVLOS waiver applications have been submitted to the FAA by commercial drone operators—99% have failed to be approved.")
525 Opinion 01/2018.
526 *Ibid*.
527 Therese Jones, *International Commercial Drone Regulation*, *supra* note 521.
528 See e.g. US, 14 CFR §107.25; Canada, SI 623-001, s 6.27.
529 14 CFR §107.39.
530 International Center for Law and Economics and Tech Freedom, "Operation and Certification of Small Unmanned Aircraft Systems" Comment, on RIN 2120–AJ60 online: FAA <www.faa.gov/uas/media/RIN_2120-AJ60_Clean_Signed.pdf>.

and privacy concerns. The widespread understanding is that technology is the solution for the many UAV related issues. A popular proposition is to adopt geo-fencing capabilities as it prevents UAVs from diverting from areas where operation is allowed.[531] So far neither Canada, Australia, US has introduced geo-fencing requirements in their regulations. Transport Canada succinctly explains that geo-fencing is only a supplementary technology and the responsibility of the UAVs conduct is upon the operator.[532] In contrast, Europe in its Opinion 01/2018 states that registration, e-identification and geo-awareness[533] are the fundamental pillars of U-Space and therefore proposes geo-awareness requirements for certain classes of UAVs.[534]

Canada's initiative in imposing mandatory liability insurance in order to qualify for an exemption is an important development.[535] In Europe, UAVs are subject to EC Directive 785/2004, which mandates insurance for all aircraft.[536] Although insurance adds to the expenses of a UAV operator, in a commercial setting, the liability protection provided by insurance raises the confidence in UAV operators and the credibility of operations.

It is discernible that UAV regulations have indeed advanced with rising awareness as to UAV capabilities and technological improvements to ensure controlled and safe operations. But, the regulations do not provide solutions for each and every problem occurred due to UAV use. For example, the rights to flyover private property and the property owner's right to prohibit the over-flight of a UAV remains a grey area.[537] No blanket prohibition is present in any legal system for flying over private property. But the regulations prescribe severe fines and

[531] House of Commons, Standing Committee on Transport, Infrastructure and Communities, *Study of Unmanned Air Vehicle Regulations: An Interim Report* (February 2017) (Chair: Hon. Judy A. Sgro); *supra* note 117.
[532] AC 600-004 *supra* note 267.
[533] Opinion 01/2018 ("geo-awareness: at present, this function is for awareness only, to support the remote pilot in complying with the limitations in the area defined by the [member states]. The term 'geo-fencing' has been replaced by 'geo-awareness' to better reflect the nature of the requirement already proposed in the [NPA 2017-05]")
[534] *Ibid*.
[535] SI No. 623-001, s. 6.31
[536] *EC, Commission Regulation (EC) No 785/2004 of 21 April 2004 on insurance requirements for air carriers and aircraft operators*, [2004] OJ, L 138/1.
[537] See Chapter 2.5 *above*.

penalties if any harm or damage is caused to people or property on the ground. However, Transport Canada recommends that recreational UAVs do not fly over private property[538] Australia, taking a more straightforward approach expresses that;

> CASA regulations do not grant an RPA operator any rights against the owner or occupier of any land on or over which operations are conducted. They do not prejudice the property rights of a person in respect of any injury or damage to property caused directly or indirectly by an RPAS operation.[539]

Hence in comparison to other countries, Australia has a clearer legal view as to the rights of the owner of the property, subjected to over-flight of a UAV.

Additionally, problems such as infringement of privacy, nuisance, utilizing UAVs for illegal activities and hacking into data remain grave concerns. The UAV regulations do not address such extended issues. UAV operators are therefore compelled to look to general criminal and penal laws, tort principles and other laws of a country to understand the full extent of legal obligations and protections. The UAV specific regulations itself are heavily fragmented and the regulatory framework is essentially a patchwork of rules, recommendations, and advisory and guidance material.

Against such a backdrop, integrating UAVs to the non-segregated airspace is challenging. The severity of the task was well demonstrated by the US who announced the ambitious plan to complete integration of UAVs to its NAS by 2015,[540] and despite ongoing efforts, to date, has failed to achieve full integration. So far, none of the countries have succeeded in providing a comprehensive set of regulations to accelerate the integration process.

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538 Transport Canada, "Flying your drone safely and legally" online; Transport Canada <www.tc.gc.ca/eng/civilaviation/opssvs/flying-drone-safely-legally.html#flying>.
539 AC 101-01, *supra* note 539 §4.8.1
540 *Supra* note 17.

5.3 The best way forward: co-regulation?

An important factor discerned from the analysis of national level UAV regulations is, the tendency of States to follow a co-regulatory approach when developing regulations. The initial stages resemble more of a traditional command-and-control approach. But as the regulations progress and the constant re-evaluating and reviewing, more and more characteristics of co-regulation have seeped into the regulatory process. The reason for the shifting regulatory approach can be attributed to the society's growing interest in UAV regulations, and the demand for comprehensive regulations to remedy the instability and uncertainty, so that UAV operations can be launched with confidence.

Co-regulation denotes a shared regulatory model between the government and the industry.[541] It is a concept which has already been widely explored in the context of internet governance and social media,[542] energy,[543] and telecommunications.[544] Co-regulation is best suited in industries grappling with fast changing factors necessitating highly complex regulations, large amounts of information and data, and diversified stakeholders. Overlapping relationships between government and independent regulatory agencies, the decentralized approach to public policy management and the strong partnerships between the government and the industry are unique to co-regulation. However, the level of involvement by the industry in the regulatory process can vary from supporting research and development to enforcing sanctions upon commercial UAV users.[545] At the time of writing this thesis, co-regulatory

[541] Clarke & Moses *supra* note 143.
[542] OECD, *State- Regulation, Self- Regulation and Co- Regulation*, online: OECD <www.osce.org/fom/13844?download=true>. ; Jonathan Cave, Chris Marsden & Steve Simmons, "Options for and Effectiveness of Internet Self- and Co-Regulation" (Santa Monica: RAND, 2008) online: RAND <www.rand.org/content/dam/rand/pubs/technical_reports/2008/RAND_TR566.pdf>.

[543] Barry Barton et. al, *Regulating Energy and Natural Resources* (Oxford: Oxford University Press, 2006)

[544] UK Office of Communications, *Identifying appropriate regulatory solutions: principles for analysing self- and co-regulation*, (2008) online: OFCOM <www.ofcom.org.uk/__data/assets/pdf_file/0019/46144/statement.pdf>.
[545] Clarke & Moses *supra* note 143

stances in the context of UAVs can be mostly demonstrated by the initiation of government backed research groups, working groups and advisory panels for the purpose of supporting the development of regulations,[546] and the heightened collaboration between the regulatory authorities and the industry by seeking comments and suggestions on proposed laws and statutes.

The EU takes a bigger step towards co-regulation by proposing to allow the authorities of the member States to issue operational authorizations to model aircraft clubs and associations.[547] The clubs and association will thereby implement either a code of conduct or a set of rules to keep its members in check. This is a very practical approach, as a main concern of many civil aviation authorities is the lack of resources to maintain oversight upon the sheer numbers of hobbyist UAVs.

It is noticeable that, as regulatory authorities started adopting more and more co-regulatory practices, the UAV regulations are more in-sync with the industry needs. As a result, the industry has achieved a steady growth.[548]

Co-regulation is well suited for the nascent UAV industry as it provides the necessary flexibility and adaptability to the regulatory framework. Compared to traditional regulatory models, co-regulation allows the entrustment of duties to responsible and competent bodies from the industry, which results is substantial cost reduction for governmental authorities.

The pragmatic nature of co-regulation assists the regulatory framework to "maintain its relevance and effectiveness in a rapidly evolving market."[549] Nevertheless, the regulatory

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[546] See e.g. *supra* note 358; (The Unmanned Aircraft System Program Design Working Group was established as a joint effort between the Canadian industry and federal government to assist in making regulations); CASA, "Aviation Safety Panel" online: CASA<www.casa.gov.au>. (The panel consists of members from the industry and tasked with directing CASA's engagement with the industry)
[547] Opinion 01/2018 at 9.
[548] Brian Wynne, "Small UAS Rule Marks First Anniversary with rapid industry growth" (6 July 2017) AUVSI (blog) online: <www.auvsi.org/industry-news/blog/small-uas-rule-marks-first-anniversary-rapid-industry-growth>; Figure 1 in Ch.3 *above*.
[549] See generally Christopher Marsden, "Co- and Self-Regulation in European Media and Internet Sectors: The Results of Oxford University's Study" 76 in *The Media Freedom Internet Cookbook* (OSCE, 2004),

authorities must be aware and maintain oversight to prevent any kind of monopolization of the industry[550] and in the case of UAVs to confirm that safety is not compromised at any event.

5.4 Conclusion

A stable legal and regulatory framework is a prerequisite for an economically viable and innovative UAV industry. The current national UAV regulations, though much improved compared to the regulations at the early stages, do not resemble a well-equipped, comprehensive legal framework. The major drawbacks being the highly fragmented nature of regulations and the unnecessary restrictions preventing the take-off of many commercial operations. Therefore, in conclusions of this thesis, it is emphasized that by embracing a co-regulatory approach, the national regulators will be able to find the perfect balance between promoting safety and fostering the industry via UAV regulations.

[550] *OECD Reviews of Regulatory Reform*: *Regulatory Policies in OECD Countries* (OECD, 2002) ann. II. at 135.

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