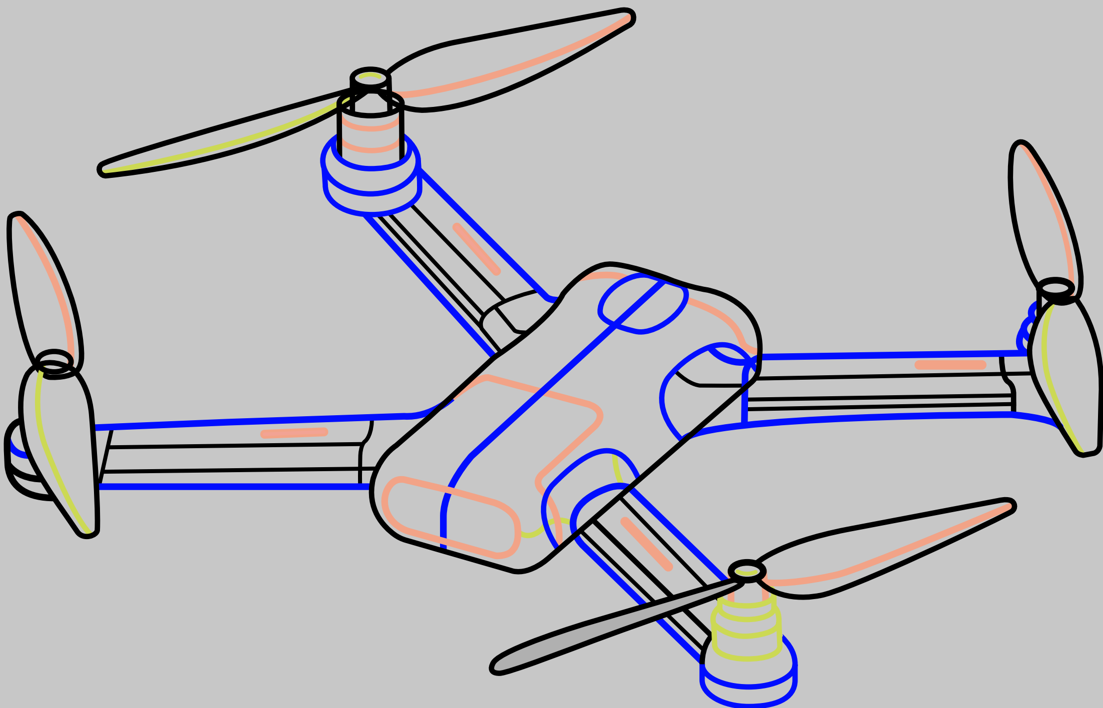
SAFETY AND SECURITY OF UNMANNED AIRCRAFT SYSTEMS

MIKKO T . HUTTUNEN

Acta electronica Universitatis Lapponiensis 295



LEGISLATING SOCIOTECHNICAL CHANGE IN CIVIL AVIATION

Acta electronica Universitatis Lapponiensis 295

MIKKO T. HUTTUNEN

Safety and Security of Unmanned Aircraft Systems
Legislating Sociotechnical Change in Civil Aviation

Academic dissertation to be publicly defended with the permission of the Faculty of Law at the University of Lapland in LS2 on 4 December 2020 at 12 noon

LAPIN YLIOPISTO
UNIVERSITY OF LAPLAND

Rovaniemi 2020

University of Lapland
Faculty of Law

Supervised by

Professor Lotta Viikari, University of Lapland

Reviewed by

Professor Anna Masutti, University of Bologna

Assistant Professor Riikka Koulu, University of Helsinki

Opponent

Assistant Professor Riikka Koulu, University of Helsinki

Layout: Taittotalo PrintOne
Cover: Hannele Määttä, University of Lapland

Acta electronica Universitatis Lapponiensis 295
ISBN 978-952-337-236-8
ISSN 1796-6310

URN: http://urn.fi/URN:ISBN:978-952-337-236-8

Contents

Foreword and Acknowledgements

A good story is rarely completely linear or makes perfect sense. Imperfections, inconsistencies, and disagreements breathe a sense of humanity. There must be suspense and excitement but also pitfalls, desperation, and deviations from the path that would be the most logical. It is these things, whatever stands out from the normal state of affairs, which grabs our attention either positively or negatively. As my imaginary mentor Michael Scott put it concerning workplace meetings,

> People expect a lot from these … laughter, some twists, surprise endings, you need to be Robin Willians and M. Night Shyamalan. You need to be Robin Shyamalan. … don't think about the stakes, it'll freak you out.[I]

The academic path I have treaded has contained many such deviations. Public international law, which I took in 2012, was the first field of law that struck a chord with me. This resulted in a desire to take several advanced courses therein. As fate would have it, the course book for the law of the sea was unavailable, so I took air law instead—a fateful incident, one might say. Albeit I later sailed the high seas as well, the airspace retained its primacy. Successfully completing my bachelor's and master's theses led me to the opportunity of doing an LLD: a PhD in law. As it seemed like an interesting thing to do, I accepted the challenge without really understanding what it would entail.

Yet as many have previously observed, doing an LLM is quite different from doing an LLD, given the expectations attached to the latter. Hence, originally (January 2015) I begun working on a book on the sovereignty of states in airspace—a grandeur topic, as my supervisor put it. After several years of struggling with the concept, though, I realized that what I would have to write was a new theory on sovereignty minus the airspace dimension, which would regardless take a few years to finish. Scrambling to retain my sanity, I decided to continue my work on another topic, which would—over the span of two years—become the present dissertation. So here I am, after some twists and surprise endings, with a finished thesis. The following words could hardly fit better:

> And I broke my promise on a very sharp rock
> And I was possessed by something quite unfriendly

I *The Office (US)*, season 5, episode 3.

And I was haunted by a demon in my sleep
And that's how I learned how to survive[II]

Even more important than finishing this thesis is, however, the experience of learning. Through writing, discussing, and publishing, I feel as if I have begun to understand what the academia is about, what scholarship is about, and what it is all worth. I started with much doubt about the potential of legal scholarship to say anything about anything meaningful at all; much of its issues appeared trifling technicalities unable to touch anyone's heart or soul. I identified with a sentiment of Juha Karhu who once remarked on the question as to what the most important thing in life is: "Certainly not jurisprudence!"[III]—although Juha's remark, I think, stemmed not out of cynicism but rather of his love of life. To be sure, I do retain some of my cynicism regarding many legal topics. However, I have come to realize that law has potential for great and interesting debates when its examiner lifts the veil of bureaucratic formalism off their face. The discussion in this dissertation on law and sociotechnical change, I hope, vindicates me. As for drones, well, I hope I am forgiven for ending up with such a techno-industrial topic.

*

During my journey, I have greatly enjoyed the help of the community of legal scholars at the University of Lapland. First and foremost, I want to thank my supervisor Lotta Viikari whose sheer professionalism in all legal research I noticed already when writing my bachelor's thesis in 2013. Whatever topic beyond her own research interests I decided to tackle, her support was unwavering. When writing grant applications, I could always rely on her recommendatory letter. She is also the one to thank for my involvement in unmanned civil aviation, starting with our research project with the Geological Survey of Finland in 2015.

The vacancy for the second supervisor remained unfilled to the very end. In the very beginning I had no idea whom I could ask, perhaps reflecting the difficulties with my original topic. Meanwhile, the present thesis was almost finished before I even considered going for another supervisor. Whether the quality of my work is severely impacted by a lack of cross-examination, which I of course hope it is not, I leave for the legal academia to decide.

Still, the combined efforts of many peers could be viewed as the unofficial second supervisor. Tomi Tuominen, who defended his excellent thesis in 2017, has greatly aided me in becoming a member of the academic community. Our extensive discussions over lunch, joint draft paper workshop, and joint teaching in

II Andrew Jackson Jihad, *Survival Song*. In *People Who Can Eat People Are the Luckiest People in the World*, track 3. Monte Sereno, CA: Asian Man Records (2007).

III *"Ei ainakaan juridiikka!"* In an interview to *Digesta*, the publication of the Lappish law student organization Artikla. The exact number of the issue escapes me.

international and EU law have always inspired me to push further on the academic path. Tomi has, of course, been quite the role model in academic pursuits, given his persistent approach to writing, reading, and discussing. Given our similar age, the term *Doktorvater* appears outlandish; perhaps *Doktorbruder* would be more appropriate. I also thank Tomi for serving as the custos in my dissertation's halfway examination in 2018.

Concerning academic brothers, I extend much gratitude to Juhana Riekkinen and Anssi Kärki who begun their LLD project at around the same time as I did and who have since both defended their superb dissertations. Through these years, our solidarity has grown beyond the sphere of work onto a personal level, of which I am extremely glad. I expected to have colleagues when starting in the academia, but having made friends is all the more worthwhile. We seem quite like the *3 idiots*, being able to co-author a piece on video games and a casual legal podcast. Here, I feel it is appropriate to also thank my closest friends outside the academia: Antti Hietala, Ville Rask, and Vili Tuominen. I am exceedingly thankful for your friendship and hospitality over the years.

Of the community of LLD students at the University of Lapland, Jenna Päläs and Kaisa-Maria Kimmel have also been tremendously helpful in clarifying what I want to say with my thesis. The dedication of both for conducting the highest quality of scholarship as well as their concern for the well-being of the Faculty and its people has always impressed me. Insightful comments by Anuradha Nayak, Olga Pushina, and Iiris Kestilä have been decisive in directing my focus at various stages. Outside the faculty, two academic professionals, Malte Krumm and Benjamyn Ian Scott, deserve much gratitude for having helped me step into the community of air law from the niche academic standpoint. Thanks also go to Jukka Hannola from the Finnish Transport and Communications Agency (Traficom) for the discussions on drones.

Three academics have served as my opponents during the journey. Matti Tupamäki (also from Traficom) conducted the halfway examination, while Anna Masutti (University of Bologna) and Riikka Koulu (University of Helsinki) conducted the final (pre-)examination. The comments provided by all three have been very valuable in finalizing the work, for which I am grateful; I am equally grateful for the superbly prompt responses to all requests and the timely fashion in which the comments were issued. Particularly, I extend my gratitude to Riikka who has agreed to act as my opponent in the defense.

I am glad to have served under two inspiring deans during my time at the Faculty of Law at the University of Lapland. When I started in 2014 (or, as a matter of fact, already when I started working on my LLB in 2008), Juha Karhu provided us all with plenty of inspiration to imagine legal realities beyond the doctrinal groundwork. He was followed in 2017 by Soili Nystén-Haarala whose encouraging words have aided me in completing the thesis and also understand the academia. In this context, I find it only appropriate to thank the library of the University of Lapland, which has always acquired me the material I need.

Besides the University, several other institutions have generously helped me pursue a doctorate in law. Past teachers at all levels of education deserve my gratitude, as without a doubt their influence still echoes in everything I do. Regarding the LLD process itself, I thank the Olga and Kaarle Oskari Laitinen Foundation (Laitisen säätiö), the Finnish Lawyers' Association (Suomalainen Lakimiesyhdistys), the Association of Finnish Lawyers (Lakimiesliitto), and the March 25th Fund (Maaliskuun 25 päivän rahasto). In particular, the grants by the given institutions enabled me to spend several months in Leiden, The Netherlands, at the International Institute of Air and Space Law. The visit was also made possible by the welcoming attitude of Pablo Mendes de Leon and other staff at the Institute, of which I am thankful.

Ultimately, there are two people without whom I would not be writing this. My parents, Pirjo and Erkki, and by extension my grandparents and other relatives, have always guided me to strive for goodness, keep an open mind, and appreciate setbacks as learning opportunities. All three values have played a key part in this project, as the discussion above suggests. I suppose one final quote is in order here:

> 弁護士はね。ピンチのときほど ふてぶてしく笑うものよ。[IV]

While at times the inner workings of the academia and the nature of my work therein might have appeared esoteric to the two of you—which might as well be for us all—your support for my career and life in general has been unwavering. For this I sincerely thank you both.

Rovaniemi, on a calm September afternoon, 2020
Mikko T. Huttunen

IV Translates officially as "The worst of times are when lawyers have to force their biggest smiles." Recurring phrase in the *Phoenix Wright: Ace Attorney* game series.

Original Articles

The thesis is based on the following original articles, which will be referred to in the text similarly to other publications attributable to authors.

I. Huttunen, Mikko (2017) *Unmanned, Remotely Piloted, or Something Else? Analysing the Terminological Dogfight*. In *Air & Space Law*, Vol. 42, No. 3, pp. 349–368. Alphen aan den Rijn: Kluwer Law International.
II. Huttunen, Mikko (2019a) *The U-space Concept*. In *Air & Space Law*, Vol. 44, No. 1, pp. 69–90. Alphen aan den Rijn: Kluwer Law International.
III. Huttunen, Mikko (2019b) *Drone Operations in the Specific Category: A Unique Approach to Aviation Safety*. In *The Aviation and Space Journal*, Vol. 18, No. 2, pp. 2–21. Bologna: The Aviation and Space Journal.
IV. Huttunen, Mikko (2019c) *Civil Unmanned Aircraft Systems and Security: The European Approach*. In *Journal of Transportation Security*, Vol. 12, No. 3–4, pp. 83–101. New York, NY: Springer.

All articles are reproduced with the permission of their copyright holders.

Figures

Figure 2 is reproduced with the permission of ICAO.

Abbreviations

AA	autonomous aircraft
ACAS	airborne collision avoidance system
ADS-B	automatic dependent surveillance-broadcast
AMC	acceptable means of compliance
ANS	air navigation service
ANSP	air navigation service provider
AOC	air operator certificate
ARC	air risk class
ATC	air traffic control
ATM	air traffic management
BVLOS	beyond visual line of sight
C2	command and control (link)
CAA	civil aviation authority
CofA	certificate of airworthiness
CONOPS	concept of operations
CS	certification specification
DAA	detect and avoid
DG GROW	Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs
DG HOME	Directorate-General for Migration and Home Affairs
DG MOVE	Directorate-General for Mobility and Transport
DG TREN	Directorate-General for Energy and Transport
EASA	European Aviation Safety Agency
EEA	European Economic Area
EFTA	European Free Trade Association
EU	European Union
Eurocae	European Organisation for Civil Aviation Equipment
Eurocontrol	European Organisation for the Safety of Air Navigation
FAA	(United States) Federal Aviation Administration
FIS	flight information service
FL	flight level
FPV	first-person view
GDPR	General Data Protection Regulation
GM	guidance material
GPS	Global Positioning System
GRC	ground risk class
ICAO	International Civil Aviation Organization
IFR	instrument flight rules
JAA	Joint Aviation Authorities
JARUS	Joint Authorities for Rulemaking on Unmanned Systems
LNTS	League of Nations Treaty Series

LUC	light UAS operator certificate
MLAT	multilateration
MS	Member State (of the European Union)
MTOM	maximum take-off mass
NATO	North Atlantic Treaty Organization
NCC	non-commercial operations using complex motor-powered aircraft
NCO	non-commercial operations using non-complex aircraft
OA	operational authorization
OJEU	Official Journal of the European Union
OSO	operational safety objective
PANEP	Pan-European Partners
PANS	Procedures for Air Navigation Services
PBN	performance-based navigation
PIC	pilot-in-command
PSR	primary service radar
RNAV	area navigation
ROC	RPAS operator certificate
RPA	remotely piloted aircraft
RPAS	remotely piloted aircraft system
RPASP	Remotely Piloted Aircraft Systems Panel
RPS	remote pilot station
SAIL	specific assurance and integrity levels
SARPs	standards and recommended practices
SERA	standardised European rules of the air
SESAR	Single European Sky ATM Research
SMS	safety management system
SORA	Specific Operations Risk Assessment
SPO	specialized operation
SSR	secondary service radar
STS	standard scenario
TC	type certification
UA	unmanned aircraft
UAS	unmanned aircraft system
UASSG	Unmanned Aircraft Systems Study Group
UAV	unmanned aerial vehicle
UNTS	United Nations Treaty Series
USAP-CMA	Universal Security Audit Programme Continuous Monitoring Approach
USOAP	Universal Safety Oversight Audit Programme
USSP	U-space service provider
UTM	unmanned aircraft system traffic management
VFR	visual flight rules
VLOS	visual line of sight
VTOL	vertical take-off and landing

1. Introduction

1.1. Manned and Unmanned

The international and European system of civil[1] air law[2]—the "body of rules governing the use of airspace"[3]—like any field of law, has been developed in accordance with certain facts, policies, and principles. By the first, I refer to physical, economic, and other kinds of facts; by the second, to standards that set out a goal that is desirable in terms of its economic, political, or social effects; and by the third, to standards that should be observed because of justice, fairness, or another dimension of morality.[4] These three have served as a basis for air law as a body of rules, the use of such rules in professional practice, and the examination thereof in legal scholarship.

This constitutes air law as a universally recognized human achievement, the existence of which is based on its sufficient divergence from other professional and scientific structures[5] and its unsolved, open-ended problems.[6] In other words, air law is a field with its own structures and questions that are distinct from, say, the law of the sea, though similarities and connections exist. Air law, in its entirety, can also be regarded as a regulatory environment in which aviation related technologies are situated. It is a context that codes which acts are allowed, prohibited, encouraged, discouraged, incentivized, and so forth.[7]

One of the most central facts of modern civil aviation has been that it is virtually always manned aviation: the aircraft are operated from within the aircraft.[8] In other words, one of the legal subjects of air law, the pilot, has commonly been located aboard the aircraft. The kind of aircraft that are designed to operate without a

1 This study only focuses on civil aviation, as opposed to state aviation. See in detail below.

2 Air law has interchangeably been called aviation law, aerospace law, aeronautical law, law of airspace, and so forth. See Scott & Trimarchi 2020, p. 1. As described below, the present study focuses on aviation safety and security law, a subset thereof.

3 Diederiks-Verschoor 1983, p. 1. The same definition persists in later books based on the original one. See Mendes de Leon 2017, p. 1.

4 Dworkin 1967, p. 23.

5 The distinct nature of air law is often discussed in general studies of the field. See, *e.g.*, Cooper 1951/1968, p. 3; Haanappel 2003, pp. xiii–xvi; Havel & Sanchez 2014, pp. 5–6; Keenan, Lester & Martin 1966, p. 25; Matte 1981, pp. 36–48; Mendes de Leon 2017, pp. 1–2; Milde 2012, pp. 1–4; Scott & Trimarchi 2020, pp. 2–3.

6 See Kuhn 1962/1996, pp. x and 10.

7 See Brownsword & Somsen 2009, pp. 4–5.

8 For an overview, see, *e.g.* Grant 2017.

pilot on board (unmanned aircraft systems, UAS—or drones[9]) and the use of such aircraft (unmanned aviation) have existed as kind of an anomaly[10] on the fringes of modern aviation. The history of drones extends far further than manned aircraft, as some rudimentary devices were already created in classical antiquity[11] and ancient China,[12] and many early designs of aircraft were tested as unmanned.[13] However, the age of modern aviation has been the age of manned aircraft rather than drones: manned aircraft have been the primary subjects and objects of aviation. One could say that the sociotechnical system of civil aviation is built on the premise of manned aviation.[14] Indeed, the traditional perspective of unmanned aviation limits itself to radio-controlled model aircraft[15] and military drones.[16]

The reason behind this is simply sociotechnical: it has to do with aviation technology and its related practices. The greatest benefits of aviation, besides the sheer pleasure of flying, lie in air transport and aerial work. Thus far, it has not been possible to reliably and safely, in terms of technology, conduct most such missions without having a pilot on board the aircraft. Unmanned aviation technology has been relatively expensive, difficult to operate, unsafe, and lacking useful applications. Available technology limits the kinds of aircraft and aviation infrastructure that can be manufactured and the kinds of operations that are possible using such equipment; accordingly, new technology creates new possibilities.[17] For a long time, it has been difficult to find a use for drones on a large scale.[18]

Because of this, air law has focused on creating rules for manned aviation and solving the problems caused by such aviation; conversely, drones have not caused notable legal problems and therefore there has been little need to legislate them. This can clearly be seen by looking at legal materials, case law, and legal scholarship: the "normal science" or research tradition of air law.[19] Consider, first, the very foundations of international air law. The 1919 *Convention Relating to the Regulation of Aerial Navigation* (Paris Convention), the first multilateral Convention on aviation (drafted under the auspices of the League of Nations), originally concentrated only on manned aircraft. This is testified to by the amendment of the Convention in

9 On terminology, see below and the first article of this dissertation (Huttunen 2017).
10 Kuhn 1962/1996, pp. 52–65.
11 See, *e.g.*, Huffman 2005, pp. 82 and 570–579.
12 See, *e.g.*, Needham 1965, pp. 568–602.
13 See, *e.g.*, Gillispie 1983.
14 Civil aviation as a sociotechnical system is discussed in Vermaas et al. 2011, pp. 67–81.
15 See, *e.g.*, Bowden 1946.
16 See, *e.g.*, Sloggett 2014. For an early take on military drones, see also, *e.g.*, Armitage 1988; Munson 1988.
17 Bennett Moses 2003, p. 394; 2007a, p. 594; 2007b, p. 245.
18 There are some individual cases of drone use prior to the recent boom. For example, in Japan since the 1990s, unmanned helicopters have been used in limited fashion in agriculture. See Sato 2003.
19 See Kuhn 1962/1996, p. 10.

1929, when a single separate provision referring to aircraft "capable of being flown without a pilot" was added to the text.[20] *Convention on Commercial Aviation* (Havana Convention), an early Pan-American treaty, was similarly created for the purposes of manned aviation. Though this was not explicitly stated, a giveaway is that it referred to aircrew being "employed *on* the aircraft".[21]

The same goes for the 1944 *Convention on International Civil Aviation* (Chicago Convention), which is a now universally accepted[22] treaty, a kind of constitution of international aviation.[23] Aircraft capable of being flown without a pilot ("pilotless aircraft") have their own provision that requires such aircraft to obtain an authorization prior to flight (Article 8).[24] The provision is the same as the one in the amended Paris Convention, which the Chicago one superseded. The development of safety (and security) standards, which the Convention designates to the International Civil Aviation Organization (ICAO),[25] has so far concentrated on creating the minimum requirements for manned rather than unmanned aviation. This goes for, *inter alia*, the Resolutions adopted by the ICAO Assembly, the safety and security related standards and recommended practices (SARPs), other documents, and programs which all significantly influence the development of air law.[26]

In the European Union (EU), the main expert body in the field of civil aviation is the European Aviation Safety Agency (EASA). This Agency, which has been tasked with assisting the European Commission (the legislative body in aviation matters) in developing rules on the safety of civil aviation,[27] has also focused its efforts on manned aviation. To date, the vast majority of EU rules on matters like airworthiness, air operations, aircrew, and so forth, are tailored for manned aircraft.[28] Similarly, in domestic air law unmanned aircraft have been treated as an exceptional case. They have been regarded as being outside the realm of real aviation, operated virtually always by model aircraft hobbyists in a controlled environment. The operation of the few civil UAS has usually been designated to restricted environments rather than the shared, non-segregated airspace. Such lack of serious legislation testifies to the status of drones as outliers in air law.

---

20 *Protocol Relating to Amendments to Articles 3, 5, 7, 15, 34, 37, 41, 42, and Final Clauses of the Aerial Navigation Convention of October 13, 1919*, Art. 15, para. 2. See also Fiallos 2019, pp. 43–45.

21 *Convention on Commercial Aviation*, Art. 13, para. 2 (emphasis added)

22 The Convention has been ratified by 193 states. See *Status of the Convention on International Civil Aviation*.

23 See generally, *e.g.*, Abeyratne 2014; Havel & Sanchez 2014, pp. 28–68; Mendes de Leon 2017; Scott & Trimarchi 2020, pp. 31–56.

24 My take on the wording of the Article ("pilotless" and "without a pilot") is critical. See below and Huttunen 2017.

25 *Convention on International Civil Aviation*, Art. 37 *et seq*.

26 See the ICAO documents in the References.

27 *Regulation (EU) 2018/1139*, ch. v.

28 See the EU documents in the References.

The central role of manned aviation is also visible from how air law, as a field of science, is systematized and presented to the legal community. Treatises are drafted about the rules on manned aircraft, while rules on drones are treated as an afterthought, if at all. For example, one leading treatise makes no mention of the possibility of unmanned aviation.[29] Another high quality introductory volume only discusses UAS on a few of its over five hundred pages.[30] I do not consider this a *shortcoming* on part of these superb books; after all, writing a general treatise on a particular field of law regardless entails abridging material. The fact that drones are left without much attention merely goes to show the paradigmatic status manned aviation holds in air law.

1.2. The Rise of Drones

Air law has been a very cumulative enterprise as a profession and normal science. By this, I here refer to how it has enhanced the ability of professionals and academics to solve practical legal puzzles pertaining to aviation. It has created a precise and convincing way of arguing about questions relating to, for example, flight safety, the liability of air carriers, and the jurisdiction of states. Yet the approach and scope of air law has remained largely uniform and unchanged in its focus on manned aviation. This has to do with its paradigmatic nature, in which existing facts as well as adopted policies, principles, and rules form the substantive and methodological limits that are commonly followed.[31]

In recent years, however, the amount and functionality of unmanned aviation has greatly increased. In other words, the practical capabilities of humans have extended through the development of drone technology.[32] This has rendered less obvious some of the facts and policies on which the system of air law ultimately relies on. During the first two decades of the 21st century, drones have turned from a gimmick of a few enthusiasts into viable products with mass appeal. Already a few years ago, millions of consumer grade drones were being sold every year around the world.[33] New aviators are thus entering the airspace on a daily basis.

The massive increase in unmanned civil aviation represents a sociotechnical change[34] in civil aviation. On the side of the technical, the technology employed in aircraft has become more functional, smaller, and cheaper. Chief technological innovations, which have aided in enabling the mass production of easy to fly drones,

29 Havel & Sanchez 2014.
30 Mendes de Leon 2017, pp. 13, 312–313, 347–349, and 360.
31 See Kuhn 1962/1996, pp. 35–42 and 52; Laudan 1977.
32 Cf. Bennett Moses 2007b, pp. 245–246 (cit. Schön 1967, p. 1).
33 See, *e.g.*, *European Drones Outlook Study*, p. 8.
34 The meaning of this concept is explained in the following Chapters.

include the lithium polymer battery (lightweight and durable), brushless motor, miniature scale electronic stabilization, and global positioning system (GPS).[35] At the same time, the smaller size and improved quality of digital cameras and sensors have advanced the use of drones in photography and other types of imaging. As two authors have pointed out, drones seem to have led aviation into the third industrial revolution. This revolution emphasizes miniature digital technology, particularly the acquisition, processing, transport, and exploitation of data, rather than the sheer movement of physical objects.[36] Finally, in a globalized economy, it has become easy for manufacturers to introduce their products directly into a worldwide market at a low price point. The drone market is indeed expanding extremely rapidly.[37]

On the side of the social, the use of unmanned aircraft has become popular among consumers, which signifies a change from the idea that operating in the airspace is an exclusive activity. Simultaneously, there has been an increase in highly professional and commercial drone applications, some of which are completely new to civil aviation. This is due to some of the characteristics of drones, such as small size, built-in interfacing with mobile devices, nimble maneuvering, and automation.

Pursuant to a study conducted by the Single European Sky ATM Research (SESAR), applications of drones discussed in media include public safety and security, aerial imagery, agriculture, mapping and surveying, energy industry, real estate, and delivery. Among other applications, it has become possible to use drones to inspect infrastructure, conduct aerial surveys, analyze the health of crops, deliver parcels and medicine, and transfer information when a natural disaster occurs.[38] Drones also have potential to be used in air transport.[39] This has made them an intriguing tool for various business sectors. The diverse applications of drones lead to a great number of scenarios with their own benefits and risks.[40]

1.3. Legal Challenges and Reactions

The rise of unmanned aviation has posed a major challenge to legal systems around the world: how should the legislator react to such a sociotechnical change? Some of the issues with drones have to do with the law on privacy and data protection. Within the European Union, drones equipped with cameras or other sensors have the potential to violate *Regulation (EU) 2016/679* (General Data Protection

35 For a detailed description of the development, see Desmond 2018, especially p. 182 *et seq*.
36 Masutti & Tomasello 2018, pp. 14 and 17–19.
37 See, *e.g.*, *DRONEII Drone Market Report 2019–2014; Drones 101; EASA Opinion No 01/2020*, pp. 5 and 27–28; *European Drones Outlook Study*, *passim*.
38 Ibid., pp. 8–9.
39 Fiallos 2019, pp. 34–35.
40 See Marchant 2011b, p. 199.

Regulation, GDPR). This is because they can collect information relating to an identified or identifiable natural person, which is regarded as personal data.[41]

In the context of air law, however, perhaps the most pressing issues have related to aviation safety and security.[42] How should drone operators be approved, if at all? How should we legislate the airworthiness of drones, remote pilots, or the use of airspace? How can we prevent drones from causing harm to property, humans, and other things external to the aircraft, including acts like terrorism and smuggling?[43] How can we protect drones or their payload from physical and cyber interference, like hijacking, weaponry, and jamming?[44] Are there applicable existing rules, and what kind of issues does their potential application raise?

These concerns have overshadowed those pertaining to the organization of domestic and international air carriage, such as whether existing bilateral agreements on air carriage allow unmanned aviation, and whether treaties on air carrier liability should be applied to drones. This is because air carriage using UAS is still only a developing industry. In fact, it has been argued that, without savings provided by automation or autonomy, using drones for the given purpose may not come to fruition at all.[45] Safety rules, on the other hand, also concern aerial work (special operations) and leisure flying which are the most widespread applications of drones thus far and do not involve air carriage. Furthermore, safety, if anything, is the most traditional and critical interest[46] that air law aims to protect.

From the perspective of drones, the problem with existing aviation safety and security law lies in the factual assumptions on which it is based. It has been designed for aircraft that carry a human on board, are usually a long-time investment, commonly operate from an aerodrome, can be identified visually, can only be operated by trained personnel, and can carry particular kind of equipment. This can be seen in nearly all its aspects. In contrast, drones have no pilot on board and many of them are cheaper, have a much shorter lifespan, can operate from any location, are difficult to identify from afar, can be operated by laymen, and can only carry a limited amount of extra equipment. Existing rules, hence, display a lack of concern for the characteristics of drones and the possible transformations unmanned aviation may bring about in the future. The rules carry with them their "operational and ideological baggage."[47] In matters like airworthiness and operational approval, the traditional procedures appear unsuited for consumer

41 See *Regulation (EU) 2016/679*, Art. 4, para. 1.

42 On the distinction between aviation safety (also known as flight safety) and aviation security, see below. Here, I generally refer to the relevant rules as "aviation safety and security law".

43 See Rassler 2016, pp. 13–60.

44 See Altawy & Youssef 2016, pp. 8–14.

45 Havel & Mulligan 2015, pp. 114–116.

46 See Cockfield 2004, *passim*; Cockfield & Pridmore 2007, *passim*.

47 Stokes 2012, p. 94.

grade UAS. Security-wise the airport-centric model fails to address threats coming from elsewhere.

The problem is not that existing safety and security rules are designed for outmoded technology[48] *per se*. Manned aircraft are constantly being developed and their latest models in many aspects represent the pinnacle of modern aviation technology. Furthermore, air law has been continuously under development throughout its existence. It did not spring out of the minds of lawmakers in an instant and complete fashion;[49] rather, it has responded to many changes in aviation technology, including for example the introduction of airships, airliners, and helicopters, as well as the development of the turboprop and the jet engine, air traffic control, fly-by-wire, and supersonic flight. The problem is rather that drones present many unique features and scenarios that do not neatly fit the preconceived notions of the existing system.

There are many ways to perceive the problem. One might call it the problem of regulatory disconnection: technology advances too fast for law to keep up. UAS have emerged quite quickly as a mainstream platform and have certain controversial characteristics, which has caused a mismatch with existing rules.[50] One could equally call it a case of the well-recognized "pacing problem".[51] There are also more specific typologies to describe the situation, including concepts like uncertainty, over-inclusiveness, and obsolescence.[52] In summary, the legislator has been forced to tackle two problems. First, to what extent does or could existing aviation safety and security law apply to unmanned aviation, and what kind of issues does or would it entail? Second, what kind of legislative action must be taken to fix the issues?

The situation could hardly be described as a crisis, as the problems created by drones appear to be solvable through means of positive law.[53] Accordingly, legislators at the international and regional level[54] have taken steps to bring drones within the scope of aviation safety and security law. The International Civil Aviation Organization has primarily been interested in the very highest end of operations, since its mandate is generally limited to international aviation.[55] Its legislative project on UAS is largely

48 See Bennett Moses 2003, p. 396.
49 See Tranter 2017, p. 6.
50 See Brownsword 2008, pp. 160–166 (cit. Barlow 1994).
51 Marchant 2011a; 2011b. But see Cloatre & Pickersgill 2015, p. 4 (cit. Jasanoff [ed.] 2004).
52 See Bennett Moses 2003, pp. 396–401; 2007a, pp. 594–595; 2007b, p. 248; Drahos 1985, p. 280.
53 See Tranter 2017, pp. 8–9. See also Bennett Moses 2013a, p. 40.
54 As explained below, examining the national responses to drones mostly falls outside the scope of this study.
55 Pursuant to Article 44 of the *Convention on International Civil Aviation*, the "objectives of the Organization are to develop the principles and techniques of *international* air navigation" (emphasis added). However, ICAO has not established a clear distinction between international and domestic civil aviation. Recommendations on domestic operations may be issued and international standards have a spillover effect, despite the lack of clear competence. See Huang 2009, pp. 66–69 and 227–228. In more abstract terms, this has to do with the normative pluralism of aviation safety and security law. See below.

explained in the 2015 *ICAO Document 10019: Manual on Remotely Piloted Aircraft Systems*. The Organization had already prior to the Manual amended some of the safety rules annexed to the Chicago Convention and, at the time of writing this, is working to issue more amendments.

European Union, meanwhile, has sought to legislate all kinds of drones flying within the territory of its Member States (MSs). One of the most crucial steps was taken in 2015, when the European Aviation Safety Agency issued *EASA Advance Notice of Proposed Amendment 2015-10*. In the document, the Agency suggested creating rules for drones in a risk and performance-based manner in three categories: open, specific, and certified.[56] Since then, the plans have come into fruition, as in 2018 the new EASA Basic Regulation laid down essential requirements for drones,[57] and in 2019 the Union adopted operational as well as design and manufacturing regulations for the first two categories.[58] The current focus of EASA is on developing rules on the certified category and the management of unmanned air traffic (U-space). Drafts for legislating the latter topic went into circulation in early 2020, which anticipates their impending adoption, albeit airspace and defense industries have voiced some criticism.[59]

On the face of it, legislating drones appears simply a matter of drafting new rules. However, on a closer look, the project has been much more complex. In the undertakings of ICAO and the EU, we can detect several approaches to legislating unmanned aviation. For long, the legislators decided to remain passive, not doing anything to address the problem. More recently, though, there has been an explicit attempt to replicate and emulate existing aviation safety and security rules and instruments in the legislation of drones.[60] However, with regard to certain subject matters, it has been necessary to create altogether alternative rules and instruments that deviate from existing ones. Finally, though least commonly, legislators have hinted that the existing system could at some point be transformed altogether to better reflect contemporary digital technology. Often the adopted solutions represent a mix of these approaches. This variance in legal approaches to the sociotechnical change caused by civil drones gives interesting insight into the relationship between law and technology.

---

56 See below for details.

57 *Regulation (EU) 2018/1139*, Annex IX.

58 See *Commission Delegated Regulation (EU) 2019/945; Commission Implementing Regulation (EU) 2019/947*.

59 See *ASD Position Paper: The Unmanned Aircraft Systems Traffic Management (UTM) Regulation*.

60 By instrument (in the last two articles: institution) I refer to, for example, airworthiness certification, which is a distinguishable collection of rules that serve a unified set of purposes.

1.4. Existing Studies

In recent years, the increase in unmanned civil aviation has provoked several legal treatises and dozens of academic legal articles on the topic.[61] From the perspective of European air law, two volumes in English[62] stand out. The first of these is the 2016 collection of essays edited by Benjamyn Ian Scott, titled *The Law of Unmanned Aircraft Systems: An Introduction to the Current and Future Regulation under National, Regional and International Law*. The second and more recent one is the *International Regulation of Non-Military Drones*, written by Anna Masutti and Filippo Tomasello, published in late 2018.

From the viewpoint of law and society in general, drones are under focus in *The Future of Drone Use: Opportunities and Threats from Ethical and Legal Perspectives*, edited in 2016 by Bart Custers. A similar perspective is taken in *Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance*, edited in the same year by Aleš Završnik. In 2019, Fernando Fiallos defended his PhD thesis titled *Legal perspectives on the cross-border operations of unmanned aircraft systems*, which deals with the application of the Chicago regime and the regime on international air transport to UAS.

German jurisprudence likewise offers several treatises. Perhaps the first modern dissertation on civil drones was done already in 2012 by Claudia Kornmeier, focusing on UAS and data protection. Wolfgang Kutschera discussed the law on the use of drones in Austria and the EU in his 2016 dissertation, while Milan Plücken's 2017 dissertation concerned the ICAO and EU rules on drones. Other books include Silvio Hänsenberger's thesis on civil liability for damages caused by drones according to Swiss law, and Benedikt Groh's comparative study on drone rules in Germany and the United States of America.[63] Two non-dissertational books on drones have also been authored: the first by Elmar Giemulla, Heiko van Schnydel, and Achim Friedl,[64] and the second by Markus Christen, Michel Guillaume, Maximilian Jablonowski, Peter Lenhart, and Kurt Moll.[65]

Outside Europe, several volumes have been drafted. Donna Dulo's 2016 *Unmanned Aircraft in the National Airspace: Critical Issues, Technology, and the Law* is a comprehensive take on a wide range of legal issues. The discussion focuses chiefly on the federal and state law of United States of America. The same goes for Timothy Ravich's 2017 *Commercial Drone Law: Digest of U.S. and Global UAS Rules, Polices,*

61 A vast number of legal and non-legal studies on military drones, falling outside the scope of this dissertation, have also been conducted on drones.

62 Due to linguistic limitations, a comprehensive overview of all legal studies on drones unfortunately cannot be provided in this section.

63 See Groh 2019; Hänsenberger 2018; Kornmeier 2012; Kutschera 2016; Plücken 2017.

64 Giemulla, Schnydel & Friedl 2017.

65 Christen, Guillaume, Jablonowski, Lenhart & Moll 2018.

and Practices. Meanwhile, Henry Perritt's and Eliot Sprague's *Domesticating Drones: The Technology, Law, and Economics of Unmanned Aircraft* (2017) is drafted from a more global perspective. Two Australian authors, David Hodgkinson and Rebecca Johnston, authored in 2018 a book called *Aviation Law and Drones: Unmanned Aircraft and the Future of Aviation*, which deals with the topic in various ways.

When it comes to articles, drones have been under serious legal discussion at least since 2009. In that year, the *North Dakota Law Review* devoted a special issue to the regulation of UAS.[66] In 2015, the *DePaul Law Review* did the same on the basis of a symposium.[67] Several pieces have appeared on air law journals, such as *Journal of Air Law and Commerce*[68] and *Annals of Air & Space Law*.[69] In Europe, drones and law have been analyzed in, most notably, *Air & Space Law*,[70] *Zeitschrift für Luft- und Weltraumrecht*,[71] and *The Aviation and Space Journal*.[72]

While the aforementioned studies are valuable contributions, they are somewhat lacking when it comes to what I consider the two key issues with drones: first, the exact problems with existing safety and security rules in relation to unmanned aviation; and second, the types of solutions the legislators have presented to solve the problems. Furthermore, the studies do not much reflect on the new rules enacted by the EU. This is only natural, as most of the studies were published before there was any definite indication about the upcoming rules. On a theoretical level, the aforementioned studies do not attempt to systematically understand the relationship between legislation and the changes in civil aviation.[73]

1.5. Research Questions and Arguments

The core elements of this article-based dissertation are the increase in unmanned civil aviation and the considerations it entails in terms of law and sociotechnical change. On an overarching level, the study deals with two questions:

I. What issues can sociotechnical change cause in relation to existing law?
II. What legislative approaches can be used to solve the issues caused by sociotechnical change?

66 See Jenks 2009; Marshall 2009; Rapp 2009; Ravich 2009; Vacek 2009.
67 See Havel & Mulligan 2015; Marshall 2015; Niemi 2015; Ross 2015; Wexler 2015.
68 See, *e.g.*, Bellows 2013; Fox 2017; Kapnik 2012; Migala 2017.
69 See Archambault & Mâzouz 2015; Castillo-Ruiz 2015; Schubert 2014.
70 See chronologically Masutti 2009; Kaiser 2011; Michaelides-Mateou & Erotokritou 2014; Straub, Vacek & Nordlie 2014; Abeyratne 2016; MacPherson 2018.
71 See chronologically, *e.g.*, Kaiser 2006; Giemulla 2007; Maslaton 2018.
72 See chronologically Roma 2014; Scott 2015; Carta, Senatore & Tomasello 2018; Masutti 2018.
73 See, however, Masutti & Tomasello 2018, pp. 7–13 (discussing the disruptive nature of drones).

To discuss these questions, I look into several issues that the increasing use of drones has presented and the legal changes such issues have initiated. In other words, I use drones as a case to provide insight into the general questions. Hence, the given questions are dealt with in the study in a more specific form:

I. What issues has the increase in unmanned civil aviation caused in relation to existing aviation safety and security law?
II. What legislative approaches have ICAO and the EU used to solve the issues caused by the increase in unmanned civil aviation?

In other words, I first assess existing law on aviation safety and security from the viewpoint of drones; second, I analyze the legislative solutions enacted to solve the issues caused by drones. This is an effort in systematizing aviation safety and security law, and the relationship between manned and unmanned civil aviation. In addition to the main questions, the study also seeks to provide some insights about the advantages and shortcomings of the new rules. However, these insights are not emphasized nor generalized, as the new rules have not been sufficiently tested in practice. The arguments of the dissertation are as follows:

1) Existing aviation safety and security law has primarily been designed for manned civil aviation.
2) Recently, the quality and quantity of unmanned civil aviation has increased, causing a sociotechnical change.
3) The change has caused the following issues in relation to existing aviation safety and security law: vacuity, misclassification, over- and under-inclusiveness, and ineffectiveness. The change may also cause some rules to become irrelevant in the future.
4) In solving the issues, ICAO and the EU have used the following legislative approaches: passivity, replication, emulation, and alternative rules. The approach of transformation may be used in the future.
5) Examining the case of unmanned civil aviation improves our understanding of the general relationship between law and sociotechnical change.[74]
6) As the legislative project is still ongoing and as the new rules are not completely without issues themselves, aviation safety and security law must continue being developed to address the change.

74 The meaning of the aforementioned issues and approaches will be explained below.

1.6. Structure and Content

The dissertation consists of the present synthesis and four research articles. The synthesis provides an overview of the argument as well as the underlying philosophical, theoretical, and methodological premises of the study. The synthesis both summarizes and builds on the articles, adding details and contextualizing their findings. Particularly, the synthesis develops the arguments and thus the theory concerning law and sociotechnical change.

Chapter 2 explains the philosophical, theoretical, and methodological foundations of the study. It outlines how the study understands the concepts of law, legislation, and regulation, including law's epistemological and ethical connections. The distinction between rules, standards, principles, and recommendations and the significance thereof to the study is also discussed. The Chapter continues with an explanation of the research methods involved in the dissertation, including the use of the doctrinal method of legal scholarship and the inspiration gained from case study methodology with regard to the theoretical contributions of this synthesis. As will be explained, the study involves both theoretical testing and development concerning law and sociotechnical change, using the increase in unmanned civil aviation as a case. The aim is to create a basis for all the arguments of the study, particularly the fifth argument, which is that examining the case of drones improves our understanding of the general relationship between law and sociotechnical change.

This argument is also the centerpiece of Chapter 3, which presents the theoretical framework of the study: a model of legislation and sociotechnical change. The Chapter begins with an explanation of the model in its entirety, starting with the question concerning the existence of sociotechnical change. Second, it presents the ways in which existing scholarship has understood the legal problems created by sociotechnical change. Particularly, the focus is on the four reasons for legal change presented by Lyria Bennett Moses in several articles. This is followed by an analysis of how her typology can be developed. Thereafter, the Chapter establishes a five-sided typology of the approaches available to legislate sociotechnical change. The limitations of the typology are then examined with regard to, *inter alia*, overarching theories about technology governance.

Chapter 4 shifts the focus of the study onto drones. It begins by analyzing two key concepts of the study, namely aviation safety and security, followed by a section that compares the characteristics of manned and unmanned civil aviation. The discussion is rather cursory, since it is impossible and unnecessary for the purposes of this study to comprehensively explain all the details of civil aviation. The objective of the Chapter is to provide a sufficient basis for the first three arguments: the way existing aviation safety and security law has been designed, the sociotechnical change caused by the rising quality and quantity of unmanned civil aviation, and the legal issues caused by the change. These arguments are substantiated by contrasting the characteristics of drones with the approach of the existing rules, highlighting the types of issues that arise. The subsections are based on different subfields of aviation safety and security law.

The fifth Chapter focuses on international and European legislative responses and approaches. The Chapter begins by giving a chronological outline—up to how it is at the time of writing this—of the legislative situation. This is followed by an analysis of how the new rules attempt to solve the issues identified in Chapter 4. In particular, Chapter 5 substantiates the fourth argument, which concerns the legislative approaches used by ICAO and the EU. Additionally, the examination of the new rules provides evidence toward the sixth argument, which calls for legislators to continue developing law to address the sociotechnical change.

Chapter 6 reiterates and completes the discursive arc of the study. This includes the research questions, the discussion seeking to answer the questions, and the conclusions drawn from the discussion. The Chapter is chiefly a summary of the core aspects of previous Chapters, but it is structured in accordance with the model of legislation and sociotechnical change rather than the substantive subfields of aviation safety and security. The Chapter thus seeks to finalize the study of drones as a case the relationship between law and sociotechnical change. In this, the Chapter primarily serves the fifth and sixth arguments, advancing slightly beyond the discussion in the previous Chapters.

The synthesis is followed by the references and, most importantly, the research articles. The first article is called *Unmanned, Remotely Piloted, or Something Else? Analysing the Terminological Dogfight*.[75] It was published in *Air & Space Law* in 2017 and deals with the theme of the study on a fundamental level. Several different terms have been used to describe and legislate drones throughout their existence: drone and unmanned aircraft system, as employed here, but also unmanned aerial vehicle, remotely piloted aircraft, remotely operated vehicle, and so forth. Various legislative bodies have not been able to come up with a single, definitive term that would encapsulate the kind of aircraft we are talking about. It would appear irrelevant which term is used, but on a closer look a problem appears: different terms have been assigned different meanings, which leads to differences in their scope of application. By introducing a misplaced concept, legal gaps may be formed and solving drone-related problems may become more difficult. Ultimately, like in this dissertation as a whole, I favor the term "unmanned aircraft systems", since it encapsulates all types of aircraft that are operated without a pilot on board, and since it properly reveals the distributed nature of drones. However, I equally point out that the term "drone" must be accepted as part of the public discourse and can be used to communicate with the general public. This has led me to employ it as a shorthand in other parts of the study, too.

75 Huttunen 2017.

The first article is an outlier in that it does not devote much attention to discussing the substantive provisions of traditional air law or the new rules for drones, as is done in the other three articles. Despite this, the paper clearly falls within the ambit of the study. It begins from the observation that while terminology for manned aircraft is established, this is not the case with drones; sociotechnical change can thus cause issues already on a conceptual level. Furthermore, the paper is an indispensable contribution as the starting point for the study. Without first understanding the object of study, writing on the substantive law on drones would have been hindered by conceptual confusion. Indeed, all the following articles make an immediate reference to the first one.[76]

The second article, *The U-space Concept*,[77] was published in *Air & Space Law* two years after the first one. It moves on to discuss the theme of the study on a substantive level. It is based on the observation that the integration of drones into the airspace has been challenging. It is difficult for drones to follow many requirements pertaining to manned aviation because, for instance, they are so numerous, easy to fly, and inexpensive. Furthermore, as mentioned, the operational functions and environment of drones differ from those of manned aviation. Hence, drone traffic is prone to create issues relating to safety, airspace management, and the enforcement of law—issues which the existing rules are unfit to tackle. In Europe, EASA's solution has been to embrace the concept of U-space, on which the article focuses. The core argument of the paper is that the digital, flexible, interoperable, and automatic character of U-space is necessary in the handing of large amounts of low level air traffic. Still, the implementation of such a system on a massive scale requires solving quite a few issues.

The third article, *Drone Operations in the Specific Category: A Unique Approach to Aviation Safety,*[78] was written during the spring of 2019 and published in *The Aviation & Space Journal* in the same year in August. The approach of the paper follows the structure of the thesis, as it deals with the conflict between the traditional rules of air law and UAS; substantively, the article deals with operational aviation safety. The main point of the article is to compare how safety elements, including the authorization of operators, the airworthiness of aircraft, and the competency of pilots are legislated in existing air law and in the European Union's new specific category of drone operations. Particularly, the article focuses on the Specific Operations Risk Assessment (SORA) method. I argue that the SORA differs greatly from the traditional multilayered approach, since it seeks to holistically incorporate various elements into one process. On the positive side, the method is flexible and understandable for drone operators; on the negative

76 Huttunen 2019a, p. 70; 2019b, p. 2; 2019c, p. 83.

77 Huttunen 2019a.

78 Huttunen 2019b.

side, the method might be too simple, permissive, and case-specific. Despite these shortcomings, though, I argue that the safety approach of the specific category represents a laudable legal innovation that will aid in integrating drones into the shared airspace.

At the very end of the dissertation, we arrive at the question of security. Written before but published after the third article, the fourth paper *(Civil unmanned aircraft systems and security: The European approach*[79]*)* discusses the given issue in the *Journal of Transportation Security*. The purpose of the article is to analyze how the new EU rules on UAS affect the intentional misuse of such aircraft as well as unlawful interference targeting them. I conclude that the latter threat is better handled by the rules than the former. The overarching problem with regard to intentional misuse, like terrorism and smuggling, is that the rules assume compliance: rogue pilots can simply ignore their obligations. However, enforcement is hindered by the fact that most drones are operated from outside aerodromes and that the pilot is separate from the aircraft. To these issues, I propose increasing security through the adoption of anti-drone technology, which indeed has been already done at multiple locations. While I suggest the EU to consider making such technology mandatory at airports exceeding a to-be-decided threshold, the most important takeaway is for states to recognize the importance of protecting critical locations for the sake of national security.

1.7. Inclusions and Exclusions

This dissertation excludes discussion on several themes pertaining to the law on unmanned aircraft systems. In accordance with the title and the very first sentence, the focus is solely on civil aircraft, excluding state aircraft. Whenever the study refers to aircraft or aviation, whether manned or unmanned, it means civil aircraft or civil aviation.[80] State aircraft include at least, per Article 3 of the Chicago Convention, "[a]ircraft used in military, customs and police services". In accordance with ICAO's position, the study regards civil aircraft simply as aircraft other than state aircraft, that is, aircraft used in other than the given government services.[81] Obviously, the exclusion stems from the fact that state aircraft are not principally subject to the international and European rules that the study examines. Unless a state decides to subject its aircraft to such rules, they fall under somewhat different ones. These rules, which encompass the whole sphere of safety

79 Huttunen 2019c.

80 At certain key points, the concept of "civil" is regardless used to emphasize the scope of the study.

81 *ICAO Working Paper LC/29-WP/2-1: Secretariat Study on "Civil/State Aircraft"*, p. 17, *in fine*. See also, *e.g.*, Abeyratne 2014, pp. 51–73. In the context of drones, see Fiallos 2019, pp. 58–67.

and security, are based on national law and standardization by military bodies like the North Atlantic Treaty Organization (NATO), depending on each state's military arrangements.

Perhaps the most noticeable theme omitted from the study is privacy and data protection.[82] The exclusion is noteworthy because some of the problems with civil UAS have to do with their capability to collect personal data. The exclusion may appear unsatisfactory from the perspective of drone operators. In order to comprehensively grasp what is permitted in operations that can invade privacy or utilize technology that collects personal data, one must also be aware of rules that are outside the ambit of aviation safety and security law. Additionally, as hinted above, increasing the capability of civil aircraft to collect personal data is part of the sociotechnical change caused by drones.

Despite the importance of the issue, the reasoning behind the exclusion is justified in terms of scope. Systematically speaking, aviation safety and security law is a field of law clearly distinguishable from the law on privacy and data protection: the purpose and scope of these legal regimes is different, which allows treating them separately.[83] The choice to focus on the safety perspective is supported, first, by its primacy: as noted, the primary *legislative* challenge with drones has been their safe use among manned aircraft. The second reason for focusing on the safety perspective is its broad scope: it also encompasses (the many) use cases in which privacy or personal data is of no concern.

Another factor to consider is the strength of the arguments presented in the study. Given the limitations of writing a dissertation, discussing privacy and data protection would essentially entail less emphasis on the substantive topics of safety and security. This could result in a more expansive but less convincing case both doctrinally and theoretically. Finally, the privacy and data protection implications of drones have already been discussed in legal literature and reports in a doctrinal manner.[84] This leaves us with examining them theoretically as part of the sociotechnical change in civil aviation, which could be seen as an opportunity for future studies.

This dissertation focuses on the legislating of UAS at the international and European[85] level. The dissertation only examines written law, as opposed to case law, for a very simple reason. At the international or EU level, there have been to my knowledge no legal cases concerning aviation safety and security law. While there probably have been such disputes at the national level, attempting to discover any

82 See *Privacy Code of Conduct: A practical guide to privacy and data protection requirements for drone operators and pilots*. See also, *e.g.*, Masutti & Tomasello 2018, pp. 219–228.
83 Whether upholding these regimes as separate (in the context of drones) is the optimal legislative strategy is a meta level question worth considering but simply did not fit within the scope of this study.
84 See above regarding existing studies.
85 By European, I here refer to the Member States of the European Union in addition to the non-Member States who have and possibly will adopt the drone rules developed by EASA and adopted by the Union.

such cases from all the Member States would have been an effort beyond the scope of this study.[86] While the case studied is the increase in drone aviation in European airspace in particular, it is necessary to investigate international rules, too, as they guide legislation at the regional level.[87] Internationally, the focus is on the Chicago Convention and, more specifically, documents enacted by the International Civil Aviation Organization:[88] SARPs, a few drone-specific recommendatory documents, and a few other documents like Procedures for Air Navigation Services (PANS). The last are only explored cursorily.[89]

The choice to examine such documents is obvious, as ICAO is the most central party in developing international rules on aviation safety and security. While the Chicago Convention recognizes the sovereignty of states in their airspace,[90] it also mandates the Organization to adopt and amend, as may be necessary, SARPs and procedures dealing with nearly every aspect of civil aviation.[91] This is based on the necessity of having minimum safety and security rules at the international level, which enables states to recognize each other's competency to ensure safety through documents like airworthiness certificates. The broad mandate of ICAO has resulted in a large variety of instruments that should be taken into account in every discussion on aviation safety and security. Besides ICAO, the study considers some of the work of the Joint Authorities for Rulemaking on Unmanned Systems (JARUS), to the extent such work has been or has the potential to be adopted by ICAO or the EU. JARUS is, per its own words, an international expert group that consists of national authorities and industry stakeholders, which has created recommendations on several aspects of operating drones.[92]

The choice to focus on European rules, as opposed to those of another regional arrangement or some major jurisdictions, like the US or China, comes primarily from the fact that I conducted this study in Finland, a MS of the Union. The choice to focus purely on European *Union* rules, as opposed to including European states

---

86 Finding such cases is burdensome for several reasons. First, there are differences in how MSs handle legal disputes, making it hard to find the body in charge of such cases; second, accessing court documents as a foreigner is a challenge in itself; and third, I lack the linguistic skills to understand the decisions of the vast majority of jurisdictions. It is also worth noting that none of the national cases discovered in this manner may have had anything to do with unmanned aviation.

87 See Chapter 2 for a short note about the normative pluralism of aviation safety and security law.

88 On ICAO generally, see Havel & Sanchez 2014, pp. 55–68 and 177–182; Mendes de Leon 2017, pp. 34–37 and 291–324; Scott & Trimarchi 2020, pp. 57–81.

89 ICAO also ensures safety through guidance material, the Universal Safety Oversight Audit Programme (USOAP), the Universal Security Audit Programme Continuous Monitoring Approach (USAP-CMA), safety and security management programs, and by instituting safety oversight responsibilities on states. See Mendes de Leon 2017, pp. 296–297; Fiallos 2019, pp. 151–152.

90 *Convention on International Civil Aviation*, Art. 1.

91 Ibid., Art. 37.

92 *JARUS: Who We Are*. JARUS's recommendations by themselves are not legislation, and this study does not regard them as such.

that are not MSs, comes from the fact that the Union comprises the vast majority of European states. Furthermore, one must recall that the safety (and, to an extent, security) rules are developed by the European Aviation Safety Agency, membership in which is open to European non-EU states that have made an accession agreement with the Union.[93] This, for now, includes states parties to the European Free Trade Association (EFTA): Liechtenstein, Norway, Iceland, and Switzerland. The first three have accessed EASA through membership in the European Economic Area (EEA),[94] while the Swiss have their own arrangement.[95] Certain other states, like Ukraine, also implement EU aviation rules through working arrangements as Pan-European Partners (PANEP) of EASA.[96]

There are also other reasons to focus on EU rules. The EU rulemaking effort affects hundreds of millions of potential end users, consolidates the viewpoints of divergent states, and contains many legislative innovations. It is a particularly worthwhile framework to examine. An interesting prospect would be to study how the pan-European rules are ultimately implemented at the national level, but such a project is only possible once national practice concerning the new drone rules begins to emerge.

In terms of EU documents, the most important one is the EASA Basic Regulation. It provides the Agency with its mandate to develop implementing and delegated regulations, and it contains numerous essential safety standards. Besides it, the study explores Commission regulations on matters central to the topics studied: airworthiness, air operations, airspace, licensing, and of course drones, on which the most recent regulations focus on. Since the study has been conducted during the Union's legislative process for drones, at times it refers to the drafts of and proposals for rules that have since been adopted.

As international and European rules are under focus, the synthesis and the articles largely disregard national legislative, administrative, and judicial action on drones. Perhaps the most significant exception to this is the first article in which the practice of the United States Federal Aviation Administration (FAA) is accounted for when discussing the terminology surrounding drones. This is because the terminological discussion required comprehensively considering all the terms used for UAS. Some references to the regulating of drones by the FAA and other national administrative bodies can also be found in other footnotes. They illustrate the points being made but do not represent the main legal content under examination.

93 *Regulation (EU) 2018/1139*, Art. 129.

94 See *Decision of the EEA Joint Committee No 179/2004; Decision of the EEA Joint Committee No 163/2011; Agreement on the European Economic Area*, Annex XIII. The most recent EASA Basic Regulation is yet to be incorporated into the Agreement.

95 *Agreement between the European Community and the Swiss Confederation on Air Transport*.

96 *Working Arrangement between the European Aviation Safety Agency (EASA) and the State Aviation Administration of Ukraine (SAAU)*.

It is worth noting that the provisions of the Chicago Convention and SARPs need only be applied to international aviation[97] per the scope of the Chicago regime. However, since safety and security SARPs are commonly followed in national aviation, too, the study does not make a consistent effort at distinguishing whether the drone operates nationally or internationally. Neither does the study discuss whether a drone operation is international if it takes place within the airspace of a single state but the remote pilot is located in another state.[98] It is simply noted, at times, that some legal issues are not as pressing in international aviation as they are domestically, and that some approaches are more sensible when taking into account ICAO's focus on international, high-end drone operations.

The exclusion of domestic law stems mainly from the high level of international and European standardization in aviation safety and, to an extent, security. At the international level, as explained below in more detail, states commonly adhere to ICAO's standards and recommended practices. The SARPs, albeit quite tentative at this stage with regard to UAS, represent the big picture and dictate the course of national legislation. At the European level, the EU—as guided by EASA as the expert body—has uniformly created binding rules on nearly all aspects of aviation safety and security. Detailed and comprehensive rules have been the goal of the drone regulations, too. Since many such rules have already been enacted by the Union, to focus on national rules is to look backwards. Although thus far ordinances issued by national civil aviation authorities have been the primary measure of regulating drones, such have been superseded to an overwhelming extent by the developing EU framework. As noted above, many non-EU states follow EU aviation safety rules and thus most likely the developing drone rules, too. Paying attention to the national deviation from EU rules, which is allowed in some respects, is a perspective too fragmentary to be included in the thesis.

Despite focusing on aviation safety and security law, the study does not deal with the so-called conventions on aviation/aerial crime. The main purpose of these instruments, which include for example the Tokyo[99] and Hague Convention,[100] is to internationally criminalize acts harmful to civil aviation. Their other main purpose is jurisdictional: to ensure that the perpetrators of such acts face trial regardless of

97 By "international aviation", I refer to aviation in which the aircraft flies outside the airspace above the territory of the state of departure *or* in which the area of departure belongs to no state. Meanwhile, by "national aviation" or "domestic aviation" I refer to aviation in which the aircraft remains within the airspace above the territory of the state of departure. This is a slightly altered version of the definition I adopted in the second article of the study (Huttunen 2019a), and the one used by Fiallos (2019, p. 106, fn. 20). On the horizontal and vertical limits of airspace, see, *e.g.,* Oduntan 2012. On territory in general, see, *e.g.,* Shaw 1982.

98 Cf. Fiallos 2019, pp. 106–110.

99 *Convention on Offences and Certain Other Acts Committed on Board Aircraft.*

100 *Convention for the Suppression of Unlawful Seizure of Aircraft.*

the location of the act.[101] The main reason for excluding the conventions is that providing a systematic analysis of them in relation to drones could not be provided as part of the articles. Substantively, it is also worth pointing out that the conventions target acts that are mostly relevant in international passenger transport, which is not yet practiced in a noteworthy manner in unmanned aviation. Furthermore, as pointed out in the fourth article of this study, the conventions focus on punishing perpetrators rather than preventing incidents, the latter being the focus of this study.

Much of international and EU aviation law is dedicated to deciding on the liability of the air carrier for damages to passengers, baggage, cargo, and third parties.[102] Aircraft financing, also known as rights in aircraft, is another major subfield of international air law.[103] Here, such questions in the context of drones are left without attention because they fall outside the context of aviation safety and security law.[104] The study also disregards rules that do not fall within the scope of air law. This exclusion might be obvious already from the onset. However, it is worth noting, since aviation security is affected by many measures outside air law. This includes laws on the police, military, and intelligence, to name a few institutions.[105] The picture the study provides on the numerous issues of aviation security is thus limited but inevitably so, as a comprehensive treatment is not possible nor perhaps even desirable.

---

101 See in detail Huang 2009 and 2017; Havel & Sanchez 2014, pp. 189–211; Mendes de Leon 2017, pp. 491–521; Scott & Trimarchi 2020, pp. 118–151.

102 See, *e.g.*, *Convention for the Unification of Certain Rules for International Carriage by Air*; Havel & Sanchez 2014, pp. 251–324; Mendes de Leon 2017, pp. 149–257 and 383–405; Scott & Trimarchi 2020, pp. 152–210.

103 See, *e.g.*, *Convention on International Interests in Mobile Equipment; Protocol to the Convention on International Interests in Mobile Equipment on Matters Specific to Aircraft Equipment*; Havel & Sanchez 2014, pp. 325-391; Mendes de Leon 2017, pp. 435–489.

104 On the application of tort law to emerging technology, see Morgan 2017.

105 See Huttunen 2019c, pp. 87 and 96 (cit., *e.g.*, Sweet 2008, pp. 105–144).

2. Philosophical, Theoretical, and Methodological Aspects

2.1. Legal Elements

2.1.1. Law, Legislation, and Regulation

In accordance with the typology introduced in Lawrence Lessig's pathetic dot theory (The New Chicago School), this dissertation primarily focuses on law rather than other types of constraint (modalities of regulation). Hence, the study does not consider social norms whose regulative capability is based on the non-legal social standards of a community, nor markets that regulate through transactions. "Architecture", the factual circumstances of the world—such as the physical characteristics of different aircraft—are discussed to the extent they affect the course of legislative action, but these characteristics are not discussed as rules themselves.[106]

This study thus deals with regulation in a relatively limited meaning, focusing on what Baldwin and his co-authors have described as a set of binding rules to be applied by a specific body. It does not discuss regulation in its broad sense, including all deliberate actions of a state that seek to influence human behavior, or even more broadly, all forms of social influence regardless of who exercises them.[107] In other words, the study is interested in standard-setting, not all kinds of sustained attempts at altering behavior.[108]

More specifically, this study deals with law in a somewhat limited meaning. As the materials mentioned above imply, the focus is on written law, not administrative decisions nor court cases.[109] "Legislation" is here employed as a shorthand for written law. This is the basis for describing the legal documents and efforts by ICAO as legislation, despite the concept may be used in a more restrictive sense in legal scholarship in general. For example, viewing ICAO SARPs as "legislation" could be criticized, since disregarding them is not punished in the same way as disobeying EU regulations or domestic laws on aviation safety.

---

106 See Lessig 1998, pp. 662–664; 2006, pp. 120–137. For an interesting rework of the modalities, see Dizon 2013, pp. 84–92.

107 Baldwin, Cave & Lodge 2012, pp. 2–3. On the meaning of regulation, see also Bennett Moses 2013b, p. 4; Black 2001; Parker & Braithwaite 2003; Selznick 1985.

108 See Black 2002, pp. 25–27. On the distinction and non-distinction between rules and standards, see below.

109 On the relationship between legal decision-making in courts and sociotechnical change, see Jasanoff 1995.

Threat of sanction is, however, quite a limited criterion to decide what falls within the ambit of (written) law.[110] Furthermore, SARPs are written documents that authoritatively tell aviation practitioners how to behave, are enacted in a legally authorized manner, are generally considered as falling within the scope of air law, and have established legal significance, as is discussed below. They are not, for instance, mere guidelines created by the aviation industry or non-governmental bodies. Because of the given aspects, I find that describing the study as concerning "legislation" and "legislating" is the most accurate choice. Legislation is here viewed as a subset of regulation.[111] The study acknowledges, though, that the influence and scope of ICAO and the EU is not limited to drafting written rules.[112]

Ontologically, by which I refer to the nature of law's existence,[113] this study draws upon legal positivism. This is not explicitly stated in the articles, perhaps due to the hegemonic status of such a position in mainstream air law,[114] and thus any explanation now will ring rather hollow. Still, it should be pointed out that the underlying assumption behind the papers is the social thesis: law, at least the segment of air law this study concerns, is a social fact. In other words, the activities of human beings are the cause of air law, and air law is distinguished from what is not air law through social facts.[115] The epistemological position of the study, by which I refer to how one may gain knowledge of law,[116] follows from the ontological one. The process of identifying the existence and content of law, which I have relied on in this study, "depends exclusively on facts of human behavior".[117] The way the study gains knowledge of the segment of air law it concerns is through materials that have been enacted socially.

---

110 By this "Austinian" (see Austin 1832/1995) criterion, a notable amount of what is generally considered legislation would fall outside the ambit of legislation. For a classic rebuttal, see Hart 1961/2012. For an argument in favor of Austin, see Schauer 2010.

111 See Kosti, Levi-Faur & Mor 2019, p. 175.

112 Both, for instance, engage in discussions with the aviation industry, the aviation community, and the general public for the purpose of communicating developments and promoting aviation safety. Within the EU, EASA is the Agency chiefly in charge of such activities. ICAO also has judicial powers. These activities, according to the terminology employed here, fall within the scope of regulation but not legislation.

113 Cf. MacCormick & Weinberger 1986, pp. 9–10.

114 This is quite obvious to anyone browsing the titles and abstracts of articles published in journals of air law *(Air & Space Law, Annals of Air and Space Law, German Journal of Air and Space Law, Issues in Aviation Law & Policy, Journal of Air Law and Commerce,* and *The Aviation & Space Journal)* as well as the content of books on air law. See, *e.g.*, Abeyratne 2014; Havel & Sanchez 2014; Kean (ed.) 1982; Keenan, Lester & Martin 1966; Matte 1981; Mendes de Leon 2017; Milde 2012; Scott & Trimarchi 2020. Overall, studies within air law reflect rather briefly on their dogmatic foundations.

115 See Raz 1979, pp. 37–38. See also Leiter, *e.g.*, 1998, p. 534; MacCormick 1986, p. 129; Weinberger 1986, p. 113. But see Toh 2008 (criticizing the social thesis as being the centerpiece of legal positivism).

116 Cf. MacCormick & Weinberger 1986, p. 37.

117 Raz 1979, pp. 39–40.

Of course, the social thesis is shared by another school of legal philosophy: legal realism.[118] Yet this study cannot be regarded as an example of legal realism, neither in the American nor Scandinavian sense to the extent these can be distinguished from each other. The former, after all, is characterized by a "descriptive claim about adjudication: in deciding cases, judges respond primarily to the stimulus of the underlying facts of the case, rather than legal rules and reasons".[119] The latter, meanwhile, "demand[s] that the study of law must follow ... observation and verification which animate all modern empirical science; and ... that the fundamental legal notions must be interpreted as conceptions of social reality".[120]

The articles presented here follow neither of the two realist doctrines, as the actions or motivations of courts or administrative bodies in the application of aviation safety rules are not examined. Why this is the case is quite obvious. The research themes discussed in the study—issues presented by drones to rules on aviation safety and security, and the approaches by which lawmakers have dealt with them—do not necessitate an empirical investigation into the application of air law. The analysis and the accompanying theoretical development, which both are limited to the context of written law, can be executed from a positivist viewpoint. Observing the new rules in practice can only take place once they are applied, which was not the case (indeed it was not possible) during the course of research.

The exact nature of the social process through which law is distinguished from non-law is naturally a complex one. Within positivism, the articles constituting this study hold no explicit position to the debate between various approaches. But even when considered *post facto*, how would the articles appear different, had they presented a choice, say, between the classic Kelsenian model of regression toward the *Grundnorm*[121] and the Hartian rule of recognition?[122] Would the content of my thesis be any different, had I regarded law as institutional facts[123] or in accordance with any number of takes since based on the issues of positivism?[124]

The answer to these questions appears "probably not". The solution that likely comes the closest is that the legality (validity) of the rules studied here can be imagined as resting simultaneously on many factors. The legality of rules is affected

118 See Leiter 1998; 2001. See also Green 2019, p. 12.

119 Leiter 1996/2010, p. 252. For a recent critique of Leiter's conception of American legal realism, however, see Dagan 2018. Often, American legal realism is also defined in accordance with Oliver Wendell Holmes's (1897, p. 461) famous statement: "The prophecies of what courts will do in fact, and nothing more pretentious, are what I mean by the law."

120 Ross 1953/1959, p. ix.

121 Kelsen 1960/1967, pp. 193–195. Kelsen would, of course, argue that the regression to the *Grundnorm* is not a social but a legal fact; here, however, I use "social" to refer to all human activities, which from Kelsen's viewpoint includes both legal and social facts.

122 Hart 1961/2012.

123 MacCormick & Weinberger 1986.

124 See, *e.g.*, Dworkin 1986.

by their hierarchical position in the legal order: documents such as EU regulations represent valid law partly because they are created by competent authorities.[125] But, legality is also affected by a generally accepted social rule about what is valid safety and security law in the context of aviation.[126] There are other elements, too, such as the intersubjective belief by humans ("popular legal consciousness")[127] in validity and the regular application of norms ("sufficient grounds to assume that it will be accepted by the courts as a basis for their decision").[128] The latter two elements, although realist in that they refer to facts outside written law, may be compatible with an otherwise positivist view of law.

In this context, it is worth noting that the law on aviation safety and security is characterized by normative pluralism. This means that there are several legal orders that simultaneously claim authority on the safety and security of manned and unmanned civil aviation: the international order of ICAO, the regional orders (including, for example, the EU), and national orders. In the context of this study, normative pluralism means that the legal outlook on drones in Europe is based on overlapping legal sources: international agreements, ICAO's standards and recommended practices, regulations issued by the European Commission and Parliament, preparatory documents issued by EASA, administrative orders issued by national aviation authorities, and so forth. One could thus say that aviation safety and security law is transnational: it is beyond international and national law, and it is defined functionally to aviation as an activity.[129]

The relationship between international and EU aviation safety and security rules—given that national ones are excluded from the scope of this study—is relatively unproblematic. International rules represent the minimum safety standards and recommendations particularly in the context of international civil aviation, while EU rules represent the mandatory level of safety and security in EU Member States and certain other European states.[130] This aspect has been explained above concerning the inclusions of the present study, as supplemented by the discussion below on the legal nature of ICAO's SARPs. Hence, the nature of the relationship is not analyzed further in the study.

2.1.2. Law and Values

As Joseph Raz has pointed out, the aforementioned social thesis alone is rather nebulous when it comes to the relationship between law and morality, which itself

125 See Kelsen 1960/1967, pp. 193–195.

126 See Hart 1961/2012, pp. 91–110.

127 Ross 1953/1959, p. 71 (calling this psychological realism).

128 Ibid., p. 72 (behavioristic realism).

129 See Tuori 2017, p. 36. On legal pluralism in detail, see, *e.g.*, Schiff Berman 2012; Klabbers & Piiparinen (eds.) 2013.

130 These arrangements are discussed above.

is an important issue. If I say that a collective belief (social fact) establishes the legality of particular aviation safety rules (law), I am not claiming that the belief makes the rules morally good or bad. One's position on the moral connection of the rules ought to be established separately. Raz, being a positivist, vouches for a *strong* social thesis. Such a thesis explicitly maintains that the social facts must be first describable in value neutral terms and, second, applicable without relying on moral argument.[131] An opposing viewpoint would maintain that social facts cannot be described in such terms nor applied without recourse to a moral perspective.

The underlying position of this study is, per the classic positivist dogma, that the content of law (what, for instance, the EU Regulation on the rules of the air[132] says) can be separated from whether the law is "good" (whether such rules match particular standards of morality, efficiency, and so forth).[133] This position is functional, since it distinguishes the act of describing law from its evaluation from an external perspective. Still, the study acknowledges that there is a necessary connection between law and values. By this, I simply mean that all the rules studied here echo a particular kind of ethos, ideology. They are not objective but *have* objectives: by their mere existence, rules promote and discourage, as well as include and exclude.[134]

What sort of values does aviation safety and security law espouse? As hinted above and as described in Chapter 4, most of the air law studied here has been motivated (in its drafting phase) by factual circumstances. Such include, among other aspects, the way aircraft have been designed as well as the policy of emphasizing safety over expediency and other objectives. While safety is indeed the most important value cherished explicitly in all of air law, it often overshadows certain more controversial values, such as the freedom of movement.[135]

Air law, even such pertaining to safety and security, fundamentally promotes the movement of persons and goods. The purpose of aviation is to establish physical connections around Earth, which is seen to "greatly help to create and preserve friendship and understanding among the nations and peoples of the world".[136] The safety of civil aviation is one means by which the pursuit of such can be improved. All technical rules relating to aircraft, their operators and personnel, air traffic

131 See Raz 1979, pp. 38–40.

132 *Commission Implementing Regulation (EU) No 923/2012*.

133 Raz calls it the moral thesis (1979, p. 37) and Coleman the separability thesis (1982, pp. 140–141).

134 Kelsen 1960/1967, p. 68 (though considering the function of legal science to be value-free description).

135 *E.g.*, *International Covenant on Civil and Political Rights*, Art. 12; *Protocol No. 4 to the Convention for the Protection of Human Rights and Fundamental Freedoms,* Art. 2; *Universal Declaration of Human Rights*, Art. 13.

136 *Convention on International Civil Aviation*, Preamble, para. 1.

management infrastructure, groundhandling, security measures, and so forth, encourage and improve rather than discourage and worsen movement. This is their primary purpose.

Other values promoted by air law include whatever special purpose an aircraft is used for. As elaborated on above, manned and unmanned aircraft have many applications like the monitoring of crops, industrial oversight, filming, geological surveying, humanitarian relief, and the like. In these cases, safety and security rules advance the underlying values of these missions, including for instance human agriculture, industrial production of goods, extraction of minerals, and aiding distressed populations. This goes particularly for drones, which thus far are not used for human transport in large scale but rather for transporting goods, observing the environment, and collecting data—which is, after all, part of their alleged revolutionary character.[137]

This may seem trivial at first but becomes relevant when we consider the costs of endorsing such values. The advancements in the freedom of movement and other activities (even humanitarian aid) introduced through civil aviation are largely built on the use of natural resources and inextricably linked to another value, which is economic growth. Economic growth in aviation has, of course, often been hindered by interests of safety, aviation or otherwise, which is the primary concern.[138] Regardless, both manned and unmanned civil aviation are fueled by the idea that the extraction of natural resources and thereby the creation and maintenance of industries for various purposes is good. Simultaneously, whatever emissions and waste produced in the process (such as carbon dioxide and discarded aircraft components) is acceptable, as long as it falls within acceptable parameters set forth in air law as well as other relevant law.[139] These are the undeclared assumptions behind all air law discussed in this study, including everything from the Chicago Convention to the most specific safety standards concerning UAS. Indeed, it is important to notice that the legislative project concerning drones is also driven by a set of values.[140]

There is not much opposition to be found in written air law against the given values. Little discussion has been entertained within the field on how to choose between growth and the environment, to point out the most glaring dissonance. The freedom of movement using aircraft is dependent on an industry, the running of

137 Masutti & Tomasello 2018, pp. 14 and 17–19.

138 Consider the several cases where aviation safety bodies have suspended flight operations that use potentially hazardous aircraft. Recently, such a measure was targeted at Boeing 737-8 and 737-9 MAX aircraft. See *EASA Safety Directive 2019-01*. In recent years, air travel has also been suspended several times to curb the spreading of pandemic disease.

139 Other relevant law includes, for example, international environmental treaties, EU regulations on pollution and waste, and national environmental law.

140 See Cloatre & Pickersgill 2015, p. 5.

which may ultimately cause environmental harm that actually limits our freedom of movement. The development of aviation technology, for now, expands our options but, in the end, might play a role in diminishing our legal or practical liberty.[141] This issue naturally goes back to the Chicago Convention and the mandate of ICAO, which lack any mention of environmental interests. The system is thus normatively tinged and so has been the legislative process concerning drones. The environmental implications of mass unmanned aviation have not been fundamentally discussed in the process; if anything, drones have been sometimes seen as a more environmentally neutral alternative to legacy aviation and road traffic, in addition to the benefits drones introduce when used for environmental missions.[142]

Later on, in the work of ICAO we find initiatives favoring the environment.[143] The latest EASA Basic Regulation, too, lists "high and uniform level of environmental protection" after safety in the very beginning of the Preamble. Yet, in comparison with the ever-growing amount of air transport,[144] such an objective appears as a mere afterthought that can be taken into account but is unable to challenge the fundamental assumptions of the system. At worst, it serves as a mere reminder of the material costs of aviation. At best, to follow Dworkin's triptych,[145] it serves as a principle that can be used to balance out competing interests.

Here, too, observations concerning the cornerstones of air law come as an afterthought. The articles constituting this study, representing the positivist tradition, focus on substantive problems caused by drones to the prevailing legal system, instead of targeting the values guiding the process of legislation. The capacity of civil aviation to enhance the freedom of movement and other values at the expense of natural resources is therefore ultimately accepted. The object, the system of air law, is primarily seen as an expression of a democratic legislative process[146] and a means of tackling the necessary challenges of aviation technology. The seemingly objective, liberal, and modern method of conducting legal scholarship[147] thus prevails here, but with the present acknowledgement that such a method has been an implicit choice in itself.

Another critical perspective which is not at the forefront of the study is the conflict between the traditional aviation industry and the drone industry. Hints of

---

141 See Brownsword 2017.

142 *European Drones Outlook Study*, p. 35. See also Stolaroff et al. 2018.

143 See, *e.g.*, *Annex 16: Environmental Protection; ICAO Assembly Resolution A35-5: Consolidated statement of continuing ICAO policies and practices related to environmental protection*.

144 *Air transport, passengers carried*.

145 Dworkin 1967, p. 23.

146 The drafting of international agreements on air law and the operation of ICAO and EASA (to the extent such are discussed) are thus viewed as processes of participation of representatives and officials from all member states, rather than from the perspective of a power struggle. The study thus does not deal with the power politics and possibly undemocratic characteristics of the sovereign state system.

147 See, *e.g.*, Hunt 1986, pp. 4–8; Unger 1975, pp. 63–103.

such a conflict definitely exist, as showed by the critical position of the European Cockpit Association toward the SORA risk assessment method[148] and an industry group's position paper on draft U-space regulations.[149] On the other hand, several legacy stakeholders have embraced UAS by developing their own high-end drones,[150] or found other ways to extend their reach to the drone sector. Further knowledge could be gained by, for instance, studying various stakeholders' responses to the proposals and opinions by ICAO and EASA.[151] Despite not engaging in such a line of argumentation, this study can serve as a foundation to a more critical analysis of the players involved in the rise of unmanned aviation.

2.1.3. Rules, Standards, Principles, and Recommendations

At times, legal scholarship distinguishes between rules, standards, and principles. Recommendations are often mentioned, too. A commonly cited definition of the first two stems from Kaplow who distinguishes the concepts by "the extent to which efforts to give content to the law are undertaken before or after individuals act." An effort to give content in advance is rule-like; an effort to do so afterwards is standard-like.[152] Similarly, according to Sunstein, the former "attempt to specify outcomes before particular cases arise", whereas the meaning of the latter "depends on what happens when it is applied".[153]

Yet there are other methods of distinction. Schlag establishes the difference as follows: rules have a hard empirical trigger (drones of a particular weight…) and a determinate response (…must be equipped with a particular safety feature). Meanwhile, standards have a soft evaluative trigger (in densely populated areas…) and a soft modulated response (…the drone pilot must exercise particular caution).[154] From another perspective, standards are technical specifications,[155] and types of standards can be categorized. Stewart, for instance, distinguishes between performance, specification, and engineering standards. The first specify the required performance or a particular technology, the second specify a particular input, design,

148 See *European Cockpit Association Specific Operations Risk Assessment (SORA) Position Paper*; Huttunen 2019b, pp. 15–16.

149 *ASD Position Paper: The Unmanned Aircraft Systems Traffic Management (UTM) Regulation*.

150 *Airbus' Skyways drone trials world's first shore-to-ship deliveries*.

151 See in the European context, *e.g.*, *EASA Comment-Response Document 2012-10; EASA Technical Opinion: Introduction of a regulatory framework for the operation of unmanned aircraft*, Annex I – CRD. Curiously, the Comment Response Document (CRD) to the *EASA Notice of Proposed Amendment 2017-05 (A)* and *(B)* remains unpublished, despite the promise in *EASA Opinion No 01/2018*.

152 Kaplow 1992, p. 560.

153 Sunstein 1996/2018, pp. 22 ("a rule can thus be defined as the full or nearly full before-the-fact assignment of legal rights and duties, or the complete or nearly complete before-the-fact specification of legal outcomes") and 28.

154 Schlag 1985, pp. 382–383. The examples are mine and largely fictional; they merely illustrate the point made by the author in the context of this study.

155 See Hoenkamp, Vugt & Huitema 2013.

or piece of equipment, while the third express a performance that can be achieved only by a specific technology.[156]

The differences between principles and the other two are even less clear. Principles are defined by Dworkin, whom I have now cited several times, as standards that should be observed because they represent a "dimension of morality."[157] More recently, though, the concept of principle-based regulation has been used to refer to law that focuses on outcomes.[158]

This study maintains the understanding of principles advanced by Dworkin. Between rules and standards, however, no distinction is consistently maintained. In general, the concept of a rule is used to refer to any legal provision included in the examined documents, although sometimes the concept of a standard is used in its place. The terms are thus used interchangeably, apart from cases in which the very name of the concept, like ICAO's standards and recommended practices (SARPs), employs either term. This approach is based on the inherent difficulty of upholding such archetypes. In many cases, the legal commands discussed here assign legal rights and duties before the fact and their outcome can be read from the context, but at the same time they often leave the authorities some margin in their application. Certainly, some commands discussed here are more defined in their content while others require more interpretation, but to use a fixed distinction is not fruitful for the purposes of this study.

The futility of distinguishing the two in the present study can be illustrated with ICAO's *Annex 2: Rules of the Air*. The Annex (to the Chicago Convention) contains SARPs, yet its title indicates that these are rules. Which are they ultimately?

In the very beginning of the Annex, a provision requires "the pilot-in-command [PIC] of an aircraft [to] become familiar with all available information appropriate to the intended operation" prior to a flight.[159] The content of the provision's first part is clearly determined in advance: it concerns the PIC of an aircraft, not for example "the person who controls the aircraft" who is, in some cases, the first officer. Meanwhile, the concept of "all available information appropriate to the intended operation" is contextual, depending on the location and type of the aircraft as well as the flight it is about to undertake. Furthermore, the concept is flexible in that what is regarded as appropriate information has changed over the years and will continue to do so through technological advancements and the application of the provision by national civil aviation authorities (CAAs).

Still, the concept is not flexible in that there are rules for pilots on what information

156 Stewart 1981, pp. 1268–1269. See also Bennett Moses 2005, p. 564.

157 Dworkin 1967, p. 23.

158 Black 2008, pp. 434–446 (arguing, however, that there are actually three forms of such regulation). See also Carter & Marchant 2011, p. 158.

159 *Annex 2: Rules of the Air*, para. 2.3.2.

is necessary for a safe flight. Furthermore, if a pilot fails to comply with the provision it may indicate responsibility and liability for an occurrence caused by ignoring available information such as maintenance records or weather data—when so determined through national legal procedures in conjunction with other relevant provisions. Since the content of much aviation safety and security law is such a hybrid[160] of *ex ante* and *ex post*, keeping track of each provision's character appears a fruitless exercise.[161]

When it comes to the obligatory nature of the rules discussed here, the following must be pointed out. First, it is obvious that rules enacted in EU regulations are of binding legal character.[162] Second, however, asserting the legal character of ICAO's SARPs necessitates a bit more elaboration. They gain their legal justification from Article 37 of the Chicago Convention, whose first paragraph requires states parties

> to collaborate in securing the highest practicable degree of uniformity in regulations, standards, procedures, and organization in relation to aircraft, personnel, airways and auxiliary services in all matters in which such uniformity will facilitate and improve air navigation.

Thereafter, ICAO (Council) is tasked with adopting and amending, as necessary, SARPs. Non-compliance with them triggers the obligation set forth in Article 38 to give immediate notification to ICAO Council about the deviation. SARPs are not binding treaty provisions backed up by legal sanctions, yet states are obliged to explicitly let other states know which ones they do and do not follow.

SARPs, as legal instruments, are thus situated somewhere between hard and soft law. "Standards", as distinguished from "recommended practices", seem to fall within the scope of hard law, since their uniform application has been regarded by ICAO as *necessary* and since states "will conform" with them. Meanwhile, "recommended practices" appear to fall within the ambit of soft law because their uniform application is *desirable* and because states "will endeavour to conform" with them.[163] However, as argued by a leading treatise, since SARPs are a matter of confidence, non-adherence to either kind of rules will likely cause diplomatic and economic damage. The obligation to follow SARPs is thus strongly incentivized, being backed up by a fear of non-legal adversity.[164]

---

160 Schlag 1985, p. 383, fn. 18.

161 An exception to this is, naturally, when the open-endedness of a provision is the very point made in a scholarly analysis. Yet, even then, it depends on the purpose of the study whether it is necessary to explicate the rule- or standard-like character of the provision. See in this study, *e.g.*, Huttunen 2019b, p. 10.

162 *Treaty on the Functioning of the European Union*, Art. 288, para. 2.

163 *ICAO Assembly Resolution A1-31: Definition of International Standards and Recommended Practices* (emphasis added).

164 Havel & Sanchez 2014, pp. 60–64. See also Huang 2009, pp. 58–66; Mendes de Leon 2017, pp. 294–295.

2.1.4. Doctrinal Legal Scholarship

In attempting to answer the research questions, this dissertation falls on one hand within the ambit of doctrinal legal scholarship ("doctrinal study of law"[165]). It seeks to produce information about the law and systematize legal norms.[166] Being a doctrinal effort, the study could be characterized as also being a hermeneutical one, in the sense that it is mostly about interpreting textual rules on aviation safety and security.[167] To a large extent, the study focuses on the abstract content of aviation safety and security law: the interpretive scheme for the practical application of such rules, presented as an integrated system. As hinted above with regard to legal realism, the study does not examine how such law is put into action in the observable reality.[168]

In the very first article, the doctrinal approach manifests itself in how the paper analyzes the meaning and scope of concepts employed in law. This is not to say that the paper is a work of the so-called jurisprudence of concepts, or conceptual jurisprudence *(Begriffsjurisprudenz)*. After all, such jurisprudence essentially concerned itself with the derivation of legal rules from basic legal concepts *(Grundformen, Grundtypen)*, like private property and liberty, resulting in a coherent and logical system of law.[169] Rather, the article comes closer to analytical jurisprudence, attempting to form "a logical frame built according to specifications drawn from an actual body of law."[170] Both the legal basis, implications, and the mutual relationship of the terms is under focus.[171]

In the other articles, the doctrinal examination focuses less on the meaning and delimitation of concepts and more on rules that dictate how civil aviation must be practiced. This involves describing, interpreting, and organizing rules falling within the ambit of aviation safety and security law, and describing the problems in trying to apply the law to drones. For instance, the study discusses ICAO and EU rules on matters such as airworthiness, aircrew, and air operations from the perspective of unmanned aviation.

The given discussion forms the basis of the argument that the sociotechnical change caused by drones leads to several issues in relation to existing aviation safety and security law. The argument begins from a relatively typical doctrinal standpoint. It involves describing the existing system of aviation safety and security law and presenting a novel fact situation that traditional rules are unfit to successfully deal with. The doctrinal perspective is displayed in how the articles explain the system,

165 Ross 1953/1959, p. 11.
166 Aarnio 2011, p. 19. See also Tuori 2002/2016, pp. 284 and 288–291.
167 See Aarnio 2011, p. 133; Hoecke 2011, p. 4.
168 See Ross 1953/1959, pp. 19–21.
169 See, *e.g.*, Haferkamp 2004.
170 Stone 1964, p. 138. See originally Austin 1832/1995; Hohfeld 1913.
171 Huttunen 2017, p. 351.

manifesting in legal instruments like airworthiness certification, and contrast it with drones. Of course, before and throughout the completion of this study, national, European, and international legislators have already recognized the problem that the traditional framework of air law is insufficient in addressing the special nature of drones. The novelty of the argument stems from explicating just *how* this insufficiency manifests itself, which is something not discussed in detail in the public materials of ICAO and the EU. Naturally, some of the issues identified here will still require more legislative effort to be solved, despite the new rules.

On the basis of pointing out the issues, the study presents some normative recommendations (legal politics[172]) on how drones should be regulated *de lege ferenda (lex ferenda)*.[173] These recommendations are not, however, very precise; the socio-legal opportunities[174] offered by the recognition of the problems are not fully exploited. For instance, I simply point out that the existing rules on airworthiness are over-inclusive in relation to some UAS but make no attempt at devising the proper way of ensuring the airworthiness of drones. This is mainly because, as mentioned above and as described below, ICAO and the EU have already begun issuing specific new rules and recommendations on how to solve the problems. This requires continuing the doctrinal analysis on the rules that are designed to overcome the issues investigated previously in the study. Normative recommendations should concern the possible problems with the *new* rules.[175]

From the doctrinal perspective, the analysis of the new rules is about describing, systematizing, and evaluating their content, particularly in comparison with existing rules. Hence, the articles point out just how differently the field of aviation safety and security law deals with manned and unmanned aviation. The main interest lies in the shifting structures of air law: in pointing out the differences between the approaches that have been taken with manned and unmanned aviation, and the implications the latter has for the former and aviation as a whole. Less emphasis is on the possible benefits and shortcomings; after all, as the rules at the time of writing have still been under development and not applied, identifying issues with them is not easy without profound expertise of the aviation industry. This, as an academic lawyer, I sadly lack.

Despite this, the conclusions of the last three articles all take a look at some of the pros and cons of the new rules to the extent their evaluation is possible. For example, the article on the specific category of operations lists the positive and negative aspects of the safety approach taken in the category, addresses criticism presented

172 Ross 1953/1959, p. 327 *et seq*.

173 See Peczenik 2005, pp. 2 and 4–6. See in detail Minkkinen 2013.

174 See ibid., p. 86.

175 One of such recommendations concerns the adoption of anti-drone technology. See Huttunen 2019c, pp. 15–16.

by other parties, and makes several recommendations on the implementation of the category as well as overarching policy. Similarly, the article on U-space points out the fragmentary state of current U-space capabilities across Europe and the challenges in trying to achieve full implementation. Meanwhile, the problems of the new European rules with regard to security are at the core of the fourth article.

Together, the recognition of the issues in existing law and the shortcomings in the new rules form the basis for the argument that aviation safety and security law must continue being developed to address the sociotechnical change caused by drones. This argument does *not* represent what is sometimes called the internal perspective. It is not a prescription on how to interpret a particular provision within air law to accommodate unmanned aviation. It does not adopt the perspective of a lawyer or a judge in relation to a legal case, trying to persuade the reader that a certain kind of decision should made. Nor is it a prescription to follow the viewpoints of authorities like ICAO or EASA, although the given authorities would most likely agree with the argument itself.[176]

In other words, the argument does not focus on how legal logic is developed through key rulings: the reasoning and critique of the application of law. Its purpose is not to improve the reasoning of judges.[177] Rather, the argument concerns the approach of aviation safety and security law as a whole. In a way, it is externally normative. It is a prescription to re-examine the given field of law from a new standpoint, using prevalent rules but also coming up with new ones. The argument of what ought to be stands on its own, based on observations explicated in the study, regardless of the authority of official institutions.[178]

2.2. Theoretical Elements

2.2.1. The Law and Technology Enterprise

The doctrinal side of the study, including all the articles and the relevant portions of this synthesis, focuses on how the increase of drones compels legislators to re-examine the adequacy of established aviation safety and security law. This is one of the main points of confrontation between law and science (and technology) identified by David F. Cavers already in the 1960s.[179] The given side of the study thus

176 See Smits 2012, pp. 20–21.

177 See Alter 2002, pp. 114 and 116–117.

178 See Smits 2012, pp. 20–21. However, I fail to see how it would stand regardless of empirical facts, as demanded by Smits (ibid., p. 45, *in fine*). The increasing number of drones and their characteristics, as referenced many times in this study, are empirical facts. On the distinction between the internal and external viewpoint to law, see Deflem 2008, pp. 4–5 (cit. Kronman 1983, pp. 8–14; Weber 1907/1977); Hart 1961/2012, pp. 88–91.

179 Cavers 1967, pp. 6 and 9–10.

largely follows what Peter Drahos in the 1980s called the conflict view. It focuses on the invariance or asymmetry, per Drahos's language, between drone technology and the given segments of air law. This means that existing aviation safety and security law appears as outmoded and counterproductive in relation to unmanned aviation. More precisely, drones are in disagreement with existing written and specific safety and security rules, but also to an extent they question what kind of rules are required for safe aviation.[180]

The study is not, however, characterized by the inadequacy view, which according to Drahos's typology often accompanies the conflict view. If this were the case, the claim would be that air law's structures, processes, and institutions are incapable of dealing with the increasing amount and capabilities of drones. The study does argue that there are issues in trying to apply existing rules of aviation safety and security to drones, and that in the future the rules might also become problematic in an overall manner. Yet it also notes the ways in which the relevant institutions *do* have the means of tackling the risen issues.[181] The issue discussed here is not with competence but with the state and overall approach of existing law in relation to new technology and its use. This is testified to by how ICAO and the EU have been able to issue legislative responses. Still, only the application of these responses will ultimately show the extent to which the established legal framework is adequate: the question of inadequacy, though not answered here, hence cannot be completely forgotten.

The doctrinal side of the study can perhaps more elaborately be seen as representing the law and technology enterprise, a pejorative term coined by Kieran Tranter. It begins from a specific crisis event—though, as mentioned above, crisis is too strong of a word here—involving technology, which in this case is the increase in unmanned civil aviation in European airspace during the 21st century. The study views drones as problematic technology that promises risks but also progress in the field of civil aviation. This is partly what the first research question and the first several arguments are about: What issues has the increase in unmanned civil aviation caused in relation to existing aviation safety and security law? Drones represent the future, as they are here to stay, but their rise entails both positive and negative possibilities.[182]

The problems caused by drones and the uncertain future of aviation form the need for legislative action. Through describing the existing framework of aviation safety and security law, the study finds that the rules do not sufficiently consider drones. On one hand, the rules are inadequate, but on the other hand they are excessive; the study concentrates a lot on listing inconsistencies, tensions, and gaps. There is also some speculation on how drones ought to be legislated and facilitated; law has the potential to direct how drones will be used. These build the foundations for

180 See Drahos 1985, pp. 275–278 (cit. Kirby 1977; Weeramantry 1983). See also Cortez 2014, p. 176.

181 See Drahos 1985, pp. 280–285.

182 See Tranter 2011a, especially pp. 31–32 and 69. See also Tranter 2011b.

justifying the positivist legislative project undertaken by ICAO and the EU, which is then described and assessed from a functional viewpoint—the extent to which it succeeds and fails to solve the practical safety issues caused by drones.[183]

Another notion of the law and technology enterprise, which applies to the doctrinal side of the study, is that drones and the law on aviation safety and security are viewed as relatively isolated from other fields of law. In other words, the legal analysis does not make notable effort to relate drones and air law with the emergence of other technologies or with other fields of law. This is what Tranter refers to when stating that, in the given enterprise, specific literatures are silos.[184]

As such, and as described above, the study expresses the positivist sentiment behind modern law. Legislating civil drones has chiefly been about choosing the right policy and the techniques to implement it. From such a perspective, law appears to be reduced to an instrument, a machine, a kind of technology in itself. Hence, Tranter criticizes, there is actually no law and technology enterprise, merely a technology enterprise: "the law championed to save humanity from technology is itself a manifestation of the technological mindset".[185] Prior to Tranter, Jonathan B. Wiener pointed out in rather a similar manner that

> if technology is understood in its broad sense ... then regulation is itself a technology. Regulation is a set of techniques for changing production functions to produce fewer of some outputs, such as pollution, or more of others. Regulation is the technology of governance.[186]

Tranter's argument is correct in that much of legal scholarship on emergent technology has followed a similar pattern: the acknowledgment of new technology and its use, the description of inadequacies in existing law, the *de lege ferenda* arguments for novel legislation, and, later on, the description and criticism of the new law. This is also the pattern followed in this study. He is also correct in that the urgency to legally regulate technological change has overshadowed scholarship with a more historical, general, and sophisticated outlook.[187]

In the case of civil aviation, there is also much truth to the idea that law and technology are often intertwined. This is because many standards of aviation safety

183 See Tranter 2011a, pp. 31–32 and 69. See also Leenes 2019, p. 5 (coining as "'Flawed Law Syndrome' ... the urge to call law or regulation [disconnected] and the desire to fix the problems by addressing the law, rather than using other ways to mend the assumed gaps"). In the context of courts, Jasanoff (1995, p. 6) has noted the tradition of "policies for science", which focuses "on the inefficiencies of judicial decisionmaking as an instrument for managing technology."

184 Tranter 2011a, pp. 33 and 71 (cit. Drahos 1985, p. 271).

185 Tranter 2011a, pp. 69–70 (cit. White 1985, p. 686).

186 Wiener 2004, p. 484.

187 Tranter 2011a, pp. 31 and 69–71.

and security law are extremely technical; not only that, they appear as technical best practices in a legal form, which almost dissolves their character as legal rules. Such rules bring to mind Jacques Ellul's description in which law becomes mere "judicial technique":[188] ensuring order (efficiency, security) rather than justice (what is right or fair). In accordance with Ellul's idea, technicians of air law seem to organize their subjects into behaving in a rational, perfectly controlled pattern that caters to all the smallest details of operation, lacking any indeterminacy. Indeed, in aviation safety it is difficult to distinguish between law and non-legal standards.[189]

Accordingly, as I point out in one of the articles of this study, the development of a system of unmanned aircraft system traffic management (UTM, the U-space) is equally a technological and legal effort: interplay between the two is necessary in order to bring the concept to life.[190] In fact, some might claim that the interplay is unavoidable, since law and technology are co-produced.[191] This seems risky from Tranter's perspective. As he argues, technology might not merely interact with law but seek to rival its power, being more purely modern (objective, observable, and rational) than law whose heritage is archaic and pre-rational. Technology, such as the U-space system, may symbolize an opportunity to replace aviation safety and security law with an even more rational technic of airspace management.[192]

It is quite daring of a claim that the law and technology enterprise and thus this study actually *reduces* (aviation safety and security) law to technology; that therein law cannot play a part in "sav[ing] humanity from problematic technology" but only "delivers humanity up to technology."[193] The problem of the present study is, from Tranter's perspective, that it shies away from fundamental questions about UAS technology: anxieties about its use, the costs of the legislative project(s), and the technological nature of the existing and new rules. Furthermore, the problem from that perspective is that this study merely calls for the legislation of drones and focuses on how it is done instead of arguing about the technology itself.[194] Its discussion on technological transformation does not focus on "value disputes about desired future states",[195] despite the values expressed by the increase in unmanned aviation.

The criticism hits the mark to some extent. As discussed above regarding law and values, this study has not made much of an effort to question the fundamental

188 Ellul 1964, *passim*.
189 See ibid., pp. 291–300.
190 Huttunen 2019a, p. 88. See also Mandel 2009, p. 75 ("a technology cannot advance without some freedom in research and development, but too much freedom could lead to a calamity that forecloses any opportunity for the technology.") *et seq*. This relates to the Collingridge dilemma, which is discussed below.
191 See Cloatre & Pickersgill 2015.
192 See Tranter 2002, pp. 76–77.
193 Tranter 2011a, p. 70.
194 See ibid.
195 Sarewitz 2011, p. 98.

values of air law or drones. Unlike Tranter appears to argue,[196] these values, such as the freedom of movement and enterprise and the use of natural resources for the purpose of movement and economic progress, *are* embedded in air law rather than coming from elsewhere; some opposing values like environmental neutrality (mainly in terms of noise reduction) are, too. The debate on such issues is internal to the legal discourse. However, the observation that this is the case and the possibility of weighing values like the freedom of movement against values such as the protection of environment are not explored in the study any further. The study does not begin by weighing on whether drone technology should be pursued or not, and what its meaning on our society could be for better or worse.

This shortcoming, as it could be called from the viewpoint of Tranter's critical[197] approach, can only be explained by the study's implicit acceptance of the values espoused by air law. The freedom of movement and aerial work as enhanced by drone technology are viewed largely as a positive contribution to society. Their negative aspects can successfully be controlled, including appropriate prohibitions and mitigations, within the legal regime of aviation safety and security. Of course, legislation also occurs within other regimes, like the one(s) concerning privacy and data protection, which do not fall within the ambit of this study. Hence, both safety and security are regarded as pragmatic problems in relation to existing law.

2.2.2. The Social Construction of Technology

It is somewhat difficult to contextualize the criticism toward the law and technology enterprise and, by extension, toward this study. On one hand, the criticism appears to accept a version of technological determinism, another word for which is technological substantivism.[198] According to that idea, technology—technique, to employ Jacques Ellul's term—moves all other aspects of society, including economics, politics, and law. Technology holds its own laws, having "become a reality in itself".[199] In other words, to quote Langdon Winner's definition of technological determinism in its strongest sense,

> the technical base of a society is the fundamental condition affecting all patterns of social existence and ... changes in technology are the single most important source of change in society.[200]

196 Tranter 2011a, pp. 69–70 and 76.

197 See, *e.g.*, Boyle 1992.

198 Feenberg 2002, pp. 6–8 and *passim*. See also Cockfield & Pridmore 2007; Hildebrandt 2009, pp. 451–464; Pasquale & Cockfield 2018, pp. 842–852.

199 Ellul 1964, pp. 133–134.

200 Winner 1978, p. 76. Another classic argument for determinism is presented in Heilbroner 1967. For a short overview, see, *e.g.*, MacKenzie & Wacjman 1985, pp. 4–5.

Determinism seems to lie behind the idea that the technological mindset can turn legal scholarship into technology. On the other hand, the criticism appears to accuse *the enterprise itself as being a victim of determinism*. Scholarship on law and technology allows law to be reduced to technology.

The problem with technological determinism (substantivism), as has been discussed at length, is that it overemphasizes the power of technology, underrating the power of human agency. Though technology is clearly a major driver of society, its social construction cannot be ignored. Technology and its use are shaped always in conjunction with human action, never by themselves; technology alone cannot dictate all things, including law.[201] This criticism of determinism should be applied both to the law and technology enterprise to the extent such style of scholarship follows it, but also to the criticism of such scholarship to the extent it is implicitly driven by a deterministic premise.

At the other end, however, it is unrealistic to think of technology in purely instrumental(ist) terms. According to such accounts, any new technology is a neutral tool. Technology is something rational that humans have the capability to develop, use, and alter as they please to achieve particular ends. The values served by technology are not directly embedded in the technology itself, and so technology is indifferent toward power and politics. The discussion revolves around trade-offs between different interests.[202] The problem with this is that it de-emphasizes the power of technology. It ignores how existing and future technology influences (for example, enables, includes, disables, or excludes) human behavior, including the enacting of laws. This influence has been labelled as technological normativity.[203]

The way out of the dilemma is synthesis. Borrowing from sociotechnical literature cited in the preceding paragraphs, this study sees the overall relationship between aviation safety and security law and technology as follows: such law is shaped by civil aviation technology, but the law equally shapes the technology. Neither dominates the other.[204] This is the underlying premise despite the study focuses on legislation as a reaction to sociotechnical change. Shortly put, the technological changes in civil aviation, including the increase in drones, instigate changes in international, regional, and national rules: when developments occur, there is a reason to consider legislative action. At the same time, the rules themselves steer the development of aviation technology: there is no point in developing technology that can never be expected to comply with safety and security standards.

201 See, *e.g.*, Bijker & Law 1992, especially pp. 8–11; Bijker 1995; Feenberg 1999; Jasanoff 1995 and 2004; MacKenzie & Wacjman 1985, pp. 5–24. For an overview, see Kline 2015; Smith & Marx (eds.) 1994.

202 Feenberg 2002, pp. 5–6 and *passim*. See also Cockfield & Pridmore 2007, pp. 479–482; Hildebrandt 2009, pp. 461–462.

203 Hildebrandt 2009, pp. 453–454 ("the way specific technologies constrain human and non-human interaction").

204 Cf., *e.g.*, Bijker & Law 1992.

The relationship is thus characterized by reciprocity or co-production in which both sides are contested and changing.[205] This has also been recognized in the context of law and science: science drives legal decision-making, but the judicial process also determines, for the purposes of delivering justice, what is regarded as generally valid science.[206] Another way to put it is to adopt a pluralist perspective: both law and technology are actors that are capable of shaping the world.[207]

This study implicitly follows the idea that law plays a vital part in supporting the development and use of drones, whose ultimate purpose is to improve humans' social existence.[208] But, it also notes that law, in legislating drones, protects interests other than technological progress, too. To continue with Tranter's train of thought, the effort could be described as law

> defensively trying to salvage a future by maintaining its normative vitality and ensuring the continuity of legal institutions.[209]

Yet this effort is not to be derided. By prohibiting the use of certain drones and certain ways of operating such aircraft, and by setting limitations, aviation safety and security law pushes against the technology enterprise.[210] By doing so, it gives value to other interests, chiefly the safety of humans on the ground and on board manned aircraft.[211] As noted in the article on U-space,[212] although technological developments must be considered when drafting legal standards, the development of technology is equally limited by legal necessities. These necessities are sometimes of the technological mindset, but in many cases they are not. Equating law with technology is thus unrealistic even in cases where the traditional pattern of law and technology enterprise is followed. The present study does not seek to justify a rampant offense by the technological mindset over all other viewpoints, resulting in a (dystopian) cornucopia or (cornucopian) dystopia.[213] Viewing this study as being driven purely by technology or *being* purely technology is rather a limited view of the entire relationship.

---

205 See Jasanoff 2004.

206 Jasanoff 1995, as summarized on p. 16: "law today not only interprets the social impacts of science and technology but also constructs the very environment in which science and technology come to have meaning, utility, and force."

207 Hildebrandt 2009, pp. 452–453 (discussing, however, the overall relationship between "humans and non-humans").

208 See Brownsword & Somsen 2009, p. 3.

209 Tranter 2002, p. 77 (cit. Murphy 1999, p. 275).

210 See Brownsword & Somsen 2009, p. 2.

211 Cf. Kirby 1977, p. 4 ("This leads many to suggest that the law will have an increasing role in re-asserting against the scientist and technologist, the standards which society counts as important.")

212 Huttunen 2019a.

213 See Tranter 2002, pp. 79–89.

2.2.3. Beyond the Enterprise: Law and Sociotechnical Change

Although doctrinal scholarship—the law and technology enterprise—is not here considered as problematic as in some writings, this study also seeks to provide arguments that move beyond such an enterprise. In other words, the study seeks an understanding of civil UAS also on a theoretical level, connecting the study to a broader discourse. The doctrinal analysis conducted in the articles forms the groundwork for the theoretical arguments, but the latter are presented and advanced only here in the synthesis. Hence, the theoretical aspects of the topic are an afterthought yet a vital part of the study overall.

The theoretical side of the study does not deal with legal theory or philosophy in the sense those two terms are commonly understood in legal scholarship. Neither the articles nor this synthesis present innovations regarding jurisprudential methodical elements like the doctrine on the sources of law, principles of legal interpretation, or legal argumentation. The study does not attempt to reconstruct the deep structure of law in general, including its basic legal categories and principles. In other words, the articles and the synthesis do not constitute a new general theory of law: this is not a work in legal philosophy in the traditional sense of the word.[214]

Rather, the theoretical[215] side concerns the relationship between law and technological change, or more precisely legislation and "a change in the socio-technical landscape":[216] sociotechnical change.[217] It concerns written aviation safety and security law (legislation) and modern (21st century) civil UAS, which are a new technological platform that enables new activities. Drones are thus not simply understood as legal subjects of air law but new technology created through innovation, and not only new technology but part of a change that involves new activities, connections, and so forth. This change is impacted by law and in turn has an impact on law. To be extremely exact, the claim is not at this stage that aviation technology, as a whole, is changing drastically because of drones. Although drones can pave the way for profound changes, the focus is here primarily on them and their related practices as an *addition* to the system.[218]

---

214 See Tuori 2002/2016, pp. 284 and 291–292. Overall, I favor the term "legal philosophy" over "legal theory" when discussing the discipline. There is no single "theory" but several different theories, for example the *Pure Theory of Law* (Kelsen 1960/1967). Perhaps critical takes on the structure of legal argument, such as those presented by Koskenniemi (1989/2005), can also be regarded as theories. These theories, which concern the origin and nature of law, are philosophical and thus fall within the ambit of legal philosophy but also legal practice. Similarly, in political sciences there is, *e.g.*, the realist theory (or a paradigm) of international relations and a subfield called political philosophy. Indeed, it is difficult to maintain the distinction between "legal theory" and "legal philosophy", as a later piece by Tuori shows (2006, p. 28).

215 The concept of theory used here stems from social sciences. See generally Eckstein 1975, pp. 86–90. The differences in conceptions of theory in legal scholarship and social (political) sciences has been explicated in, *e.g.*, Abbott 1992; Alter 2002, pp. 116–120. See also Tuominen 2017, pp. 16–18.

216 Bennett Moses 2013b, p. 18.

217 *E.g.*, Bijker 1995. See in detail below.

218 See Bennett Moses 2017.

In accordance with the definition of technology conceived by Donald A. Schön, as cited by Lyria Bennett Moses, drones represent a new entity along with new applications, which extend human capability in a physical manner: they enable overcoming particular physical constraints. The accuracy of such a definition is quite obvious: modern drones can indeed be used to perform tasks which used to be impossible or too expensive using manned aircraft, and their increasing use leads to new relations between natural and legal persons.[219] These include legacy aircraft manufacturers like Airbus and Boeing; entities who manage air traffic like the Air Navigation Services Finland; drone manufacturers like Volocopter; drone operators like Zipline; and end users like natural persons and agricultural businesses.

The theoretical side of the study concerns two themes: the types of legal problems created by sociotechnical change and the types of legislative approaches used to solve the problems. This exercise, in part, aims to move beyond the silo of air law by examining drones as technology and by generalizing on the basis of them. This enables the study to engage with sociotechnical change in a more sophisticated manner beyond the individual legal problems of and solutions to drones. It allows considering technology as a category, though technology is still perceived in a material sense as objects rather than a way of reasoning and being.[220]

2.2.4. The Influence of Case Study Methodology

In its theoretical pursuits, the present study draws inspiration from case study methodology.[221] This is visible in several aspects. For example, the study is qualitative rather than quantitative, since it examines a single case instead of a statistically representative number of cases; it is comprehensive rather than wide-ranging; it has been conducted in quite a flexible, improvisational, and open-ended manner; its primary evidence consists of texts instead of statistics or surveys; and finally, there is also somewhat of a narrative structure in the arguments and much description of facts and rules on drones.[222]

However, none of these is the crucial criterion.[223] The key characteristic is that the study examines, in a detailed manner, the increase in unmanned civil aviation *as a case* of law's relationship with sociotechnical change. The universe under investigation, the class of events, is thus law and sociotechnical change. Meanwhile, the event the study examines is the increase in unmanned civil aviation in European airspace

219 See Bennett Moses 2007, pp. 591–592 (cit. Schön 1967, p. 1).

220 See Tranter 2011a, pp. 71–75 (cit., *e.g.*, Drahos 1985, p. 271; Tribe 1973b, pp. 641 and 652). The last passage refers to Heidegger's (technologically determinist) philosophy in which technology is seen as revealing the world through, *inter alia*, the unlocking of natural resources. See Tranter 2007, pp. 462–466 (cit., *e.g.*, Heidegger 1954/1977, p. 16).

221 See generally Evera 1997; George & Bennett 2005; Gerring 2007; Yin 2014.

222 See Eckstein 1975, pp. 79 and 81–85; Gerring 2007, p. 17.

223 Ibid., p. 18.

during the 21st century and the legislative responses thereto.[224] This is the case, the spatially delimited phenomenon that has been observed over the given timespan. In part, the case of drones has intrinsic value due to its practical significance in the present: the importance of unmanned aviation is growing. Yet the purpose of the case is also to increase our understanding of the wider phenomenon, the class of cases.[225]

While the study fundamentally focuses on a single case, there is plenty of variation within the case. The different aspects and parties of drone operation and aviation safety and security law form a basis for numerous non-identical observations of law and sociotechnical change. Naturally, there is also temporal variation, since the study at several points encapsulates how drones and the legislative approach thereto has changed over time, and what kind of changes are to be expected in near future.[226] To put it more plainly, the increase in unmanned civil aviation, though presented here as a single case, is not a unified phenomenon but contains observations about various aspects of drone operation and rules thereon: the competence of pilots, the authorization of operators, airspace management, prevention of misuse, and the different categories of operations, to simply reiterate some key topics.

The approach of this study might be untypical, since it is a legal study that explicitly views itself as being influenced by case study methodology and describes how that is the case. Legal dissertations often do contain case studies, especially when theoretical—whether theories in the sense of social sciences or simply in the sense of abstract constructions[227]—arguments are advanced. A fitting example of this is an article-based legal dissertation in which the candidate conducted case studies of Colombian people who have been the victims of international crimes.[228] Similarly, my colleague Tomi Tuominen's dissertation labels his in-depth analyses of legal responses to the Eurozone crisis as case studies.[229]

Both dissertations provide justification for doing the studies and glaringly surpass the criteria of legal dissertation, and thus the explication of the method here may appear superfluous. However, by establishing a clear connection to the case study method as it has been practiced in social sciences, this study may provide additional self-reflection about discussing non-judicial cases in legal dissertations. It allows viewing one's argumentation from the perspective of another field of research in which such argumentation is practiced in a more widespread and systematic manner. The way this study links itself with the case study method of social sciences should thus be understood as exposing a possibility: an attempt to bridge the gap between

---

224 See George & Bennett 2005, pp. 17–18. See also Alter 2002, p. 118.
225 See Gerring 2007, pp. 19–20.
226 See ibid., pp. 29–31.
227 See above.
228 Navarro 2020.
229 Tuominen 2017, especially pp. 12–16.

some approaches in legal scholarship and social sciences, and possibly science and technology studies.

2.2.5. Theoretical Guidance, Testing, and Development

The first theoretical aspect of the study concerns the first of the two research questions: What issues can sociotechnical change cause in relation to existing law? This question concerns the types of legal problems that arise when the sociotechnical situation changes.[230] Here, given our focus on the particular case of drones, we of course deal with the question in a more specific form: What issues has the increase in unmanned civil aviation caused in relation to existing aviation safety and security law? The argument combined is that

> [the rise in] the quality and quantity of unmanned aviation [has caused] a sociotechnical change [that] has caused the following issues in relation to existing aviation safety and security law: vacuity, misclassification, over- and under-inclusiveness, and ineffectiveness. The change may also cause some rules to become irrelevant in the future.[231]

The research question and the argument are causal. If the study were to adopt the vocabulary of social sciences, the increasing unmanned civil aviation (the sociotechnical change) would be the independent variable (the cause) and the legal problems the dependent variable (the outcome). Certain aspects of the sociotechnical change cause the issues. We are thus concerned with the relation between the two: the aim is to show whether and how the characteristics and increasing use of drones have led to the issues.[232] The variables are worth pointing out, despite the fact that case-oriented research is not as concerned with them as quantitative research.[233]

The second theoretical aspect, meanwhile, concerns the legislative approaches to the aforementioned issues. It deals with the latter of the two main research questions: What legislative approaches have ICAO and the EU used to solve the issues caused by the increase in unmanned civil aviation? Therefore, it focuses on the argument according to which

> [i]n solving the issues, ICAO and the EU have used the following legislative approaches: passivity, replication, emulation, and alternative rules. The approach of transformation may be used in the future.

230 Bennett Moses 2013b, p. 14.
231 See above.
232 See George & Bennett 2005, pp. 79–83 and 127–149. See also Alter 2002, p. 117.
233 Ragin 1997.

The question and the argument are descriptive. However, when read alongside the aforementioned argument(s), they contain another causal suggestion: that the issues identified above can cause the legislator to adopt one or some of the aforementioned approaches. If we once again employ the language of social sciences, the legal problems are the independent variable, while the approaches are the dependent variable.[234] To be sure, the claim is not a normative one, such as those presented as doctrinal conclusions. Hence, this study does not assert that that lawmakers *should* follow a particular approach, nor does it provide a comprehensive take on which approach is the most appropriate in which situation. While there is some discussion on the benefits and shortcomings of the approaches both generally and in the context of drones, the purpose is not at this stage to provide overarching generalizations about the exact relationship. The claim is simply that the listed approaches offer a valid way of categorizing the phenomenon, which gains support from the case of drones. In a sense, legislators always follow the approaches in that their responses can always be categorized pursuant to the typology.

In light of the literature on case studies, the theoretical part of the study may appear idiographic. This means that it focuses on describing, explaining, interpreting, and understanding a single case. More precisely, though, the study is not purely inductive (atheoretical). Rather, it is theory-guided (interpretative), since it explicitly uses generalized concepts to bring out the interesting aspects of the case.[235] The theoretical nature of the study is quite apparent at least pursuant to Eckstein's classic understanding. It aims to provide statements of regularity or, at minimum, of probability concerning the relationship between law and sociotechnical change. The study seeks reliable and valid rules, which can correctly not only fit pre-made observations but anticipate how unknown cases turn out. Hence, it aims for foreknowledge about outcomes. The study is also parsimonious in that it offers a proportionate number of regularities.[236]

Yet it is probably mistaken to characterize the theoretical part of the study as merely idiographic, since it also involves theory (hypothesis) testing.[237] Testing in this case partly concerns the legal issues created by sociotechnical change. This is because the characterization of the issues draws upon existing theories on the legal issues caused by sociotechnical change. Particularly, the argument refers to the typology[238] developed by Lyria Bennett Moses on the reasons why legal change is promoted as a

234 See George & Bennett 2005, pp. 79–83

235 See Levy 2008, pp. 4–5; Lijphart 1971, p. 692.

236 See Eckstein 1975, pp. 86–90. Indeed, Bennett Moses (2007a, pp. 594–595) has explicitly argued in favor of a *theory* of law and technological change, part of which is the "classification scheme" of reasons for legal change.

237 See George & Bennett 2005, pp. 115–123; Levy 2008, p. 6; Lijphart 1971, p. 692. Cf. Alter 2002, pp. 117–118 (discussing the aim of political science in general).

238 See George & Bennett 2005, pp. 233–262.

response to technological (later, sociotechnical) change.[239] To an extent, there is an attempt to examine the validity of the typology by using the increase in unmanned civil aviation (in relation to existing aviation safety and security law) as a case. The case of drones may provide further evidence for generalizations.

On the other hand, the existing typologies are not simply tested as they are, but there is first an attempt to analyze their possible shortcomings and improve on them. On the side of legal issues, there is an attempt to develop several typologies, mainly that of Bennett Moses. On the side of legislative approaches, the study suggests a novel typology. The study thus does not merely test a theory but attempts to participate in the process of theory development (generation of hypotheses). The model suggested in the following Chapter actually combines the two theoretical aspects of the study into one procedural framework, a model, on how legislation deals with sociotechnical change. This model begins from the debated existence of sociotechnical change itself, considers the existence and applicability of existing rules, including the issues thereof, and ends with a scheme of several legislative approaches.

The model is essentially one widespread hypothesis, a tentative answer about legislation and sociotechnical change. This an exploratory exercise, a matter of conjecture, though not really guesswork or luck. It introduces a new idea or least a new perspective on the basis of observable action by legislators. The aim is to inductively develop a generalized typology on the possible issues and legislative reactions. To put it more exactly, the purpose is of course not to create a complete theory on the basis of a single case. Instead, the study and the model it presents should be viewed as contributing to the process of constructing a broader theory of the relationship between law and technology. In other words, I am here participating in the creation of a theory that can be developed in further studies.[240]

The model can be seen as falling within the ambit of regulation/regulatory (governance) theory.[241] In this capacity, the model describes the causalities between sociotechnical change, legislation that predates the change, and the possible legislative approaches. At the same time, it prescribes a procedure a legislator can undertake when confronted by sociotechnical change. The ambit of regulatory theory, as the following Chapter shows, is of course much wider than the model developed here. This is because regulation, as already explained above, involves many more ways of influencing behavior than this study explores: besides written law, regulation includes social norms, economic factors, and so forth. Furthermore, regulatory theories often consider approaches much more broadly than this study does.

---

239 See below for details.

240 See Eckstein 1975, p. 91; George & Bennett 2005, pp. 109–124; Gerring 2007, pp. 39–41; Levy 2008, pp. 5–6; Lijphart 1971, p. 692.

241 See generally, *e.g.*, Parker & Braithwaite 2003. See also Drahos (ed.) 2017.

One problem with using the present study in theoretical development is that there has been no predetermined strategy to guide the selection of cases or other aspects of the study's design.[242] In order to reliably test or develop a theory, among other things, the case selection would have to curb bias by considering, *inter alia*, the comparability, likeliness, or deviance of the cases. A case study that can provide strong evidence in favor of or against a theory may examine a number of cases that differ or agree in their variables; cases that should support the theory but actually weaken it; cases that should discredit the theory but actually support it; or cases that, for thus far unknown reason, do not fit the theory.[243] As has been pointed out, testing involves falsification, requiring one to "find observations that must fit a theory but have a good chance of not doing so."[244] This study does not undergo such considerations, since the case of drones was originally selected for the purposes of doctrinal legal scholarship. For this reason, its ability to confirm or reject the theories in question is limited. In constructing the arguments, the study has not exercised much caution in defining the dependent and independent variables.

Although such shortcomings cannot be amended at this stage, the theoretical implications of the study are important to present. The study introduces a new and unexplored case of the causalities[245] between law and sociotechnical change. The case provides evidence that the issues with law and technology recognized in certain fields of technology, as examined by prior scholars, can also occur in the field of civil aviation (law). Civil aviation is a useful context because it differs from the traditional three fields that have been the focus of the law and technology enterprise: biotechnology, computers, and communications.[246] The generalized thinking on law and sociotechnical change has not previously been explored in such a context. Additionally, the case of drones allows developing the generalized thinking about the legal issues as well as extending the thinking into legislative solutions. The evidence provided by this study comes in the form of a number of observations, encompassing the most relevant characteristics of aircraft operation and the legislation thereof: there is sufficient reasoning behind the theoretical development. This justifies the fifth argument of the study:

> Examining the case of unmanned civil aviation improves our understanding of the general relationship between law and sociotechnical change.

242 See George & Bennett 2005, pp. 83–84.
243 Levy 2008, pp. 7–14. See also George & Bennett 2005, pp. 22–25.
244 Eckstein 1975, p. 116 (advocating the use of crucial cases). See also Alter 2002, p. 118.
245 Gerring 2007, p. 42.
246 See Friedman 1986.

Case studies such as the one conducted here often constitute the initial evidence in creating new generalizations and conceptualizations. They represent discovery, recognizing phenomena and patterns that thus far have been left unacknowledged. Furthermore, intensively studying the increase in unmanned aviation can help in the development of a comprehensive theory, since the subject matter is examined closely. Having a large number of cases is not a value in itself when a new phenomenon is first examined and regardless suits better the process of theory testing.[247]

247 Gerring 2007, pp. 40–43 (cit., *e.g.*, Vandenbroucke 2001, p. 331).

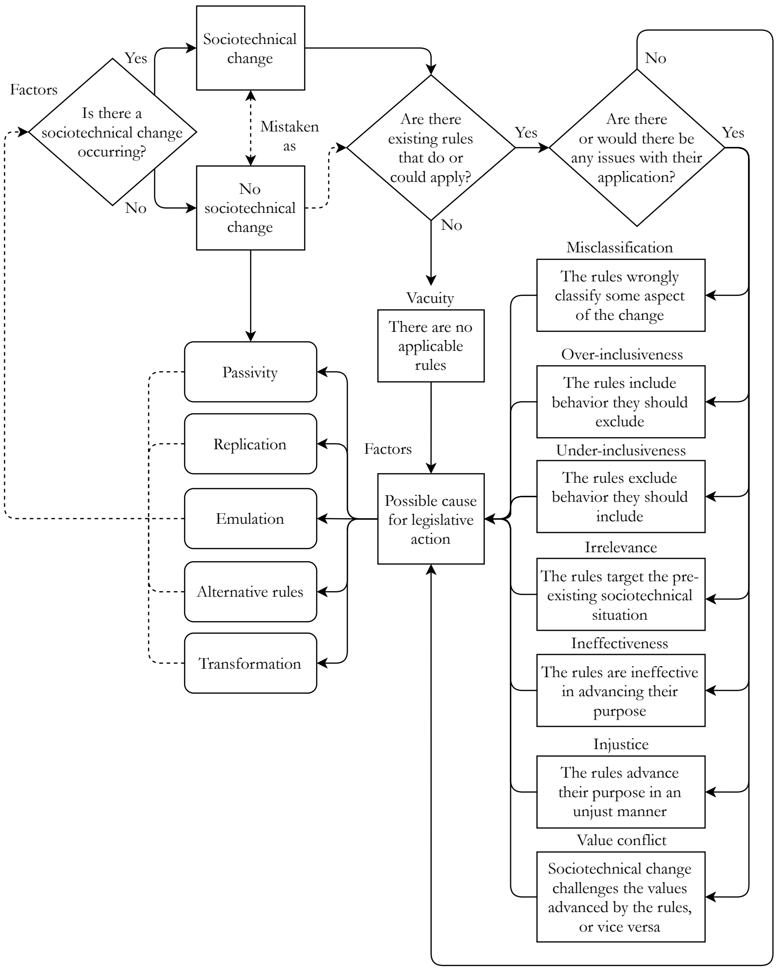
3. A Model of Legislation and Sociotechnical Change

3.1. Preliminary Questions

3.1.1. The Existence of Sociotechnical Change

The purpose of the present Chapter is to establish a model of legislation and sociotechnical change, which is the theoretical contribution of this study. In order to understand the model, it is useful to first present it as a whole and thereafter explore its various components in detail:

[Figure 1: Legislation and Sociotechnical Change]



Overall, understanding the relationship between legislation and sociotechnical change is best described as an ongoing process rather than a collection of separate aspects. To this end, any model to describe the relationship will have to begin from certain preliminary questions that concern sociotechnical change itself instead of directly discussing problems or solutions. Additionally, the model will have to take into account some negatives: there might be no change occurring, no problems with applying existing rules, or reasons why we might not desire a legislative response to sociotechnical change. Still, the model will have to offer as its main contribution an understanding of the legal issues and the legislative approaches. Finally, since the model concerns a process it should not limit itself to cases in which there certainly are rules that have already caused legal issues. The model must also incorporate issues that *would* occur, according to reasoning, if existing rules were to be applied.

To begin with, the fundamental question about law and sociotechnical change is whether there is a sociotechnical change occurring at all. The concept of sociotechnical change contains three elements. It is useful to begin from the element of the technical, which refers to technology. Naturally, there are a great number of ways to define technology. As Friedrich Rapp has pointed out, technology is historically speaking such a widespread phenomenon that it cannot be encapsulated in a single definition. Essentially, he argues, the matter is a choice between a short and vague formulation or a formulation that specifies the individual aspects of activity. For example, one could define technology simply as human action that transforms nature, or in an elaborate way as referring to particular procedures or techniques that involve engineering of some kind to produce certain outcomes.[248]

The definition employed in this study is somewhat of a compromise, since it defines technology as "any tool or technique, any product or process, any physical equipment or method of doing or making, by which human capability is extended."[249] Such a definition balances between concreteness and abstraction, and it seems suitable for understanding the artefacts, processes, and relations of the 20th and 21st century, with which the model developed here is concerned. The definition, to a large extent, also incorporates the three layers of technology recognized at times in literature. According to that idea, technology first refers to physical objects, for example drones; second, to the human development, use, and altering of technology; and third, to the knowledge of how to carry out such activities.[250]

248 Rapp 1978/1981, pp. 23–24 and 31–36. The point about history is also mentioned in MacKenzie & Wajcman 1985, p. 3.

249 Schön 1967, p. 1. As mentioned above, this definition is also cited in Bennett Moses 2007, p. pp. 591–592.

250 MacKenzie & Wajcman 1985, pp. 3–4. This understanding is also adopted in Bijker, Hughes & Pinch 1987/2012, p. xliii.

A layered understanding of technology already implies a move from "technical" to "sociotechnical", which brings us to the second element of sociotechnical change: the social (societal). By this addition, which I draw particularly from constructivist studies on technology, I emphasize that this study and the model developed here is about not only technological objects but also their related practices. As has been argued, technology should not be understood as mere artefacts. Its meaning, significance, development, and use are all socially constructed processes: technologies and their users shape each other. Technology does not act on its own. Rather, technological artefacts are part of society: they reproduce and demonstrate the interplay of technical, economic, political, and other factors.[251] Accordingly, law rarely targets the mere technology; instead, the rules actually concern the broader sociotechnical landscape.[252]

The final element of the concept is "change". This can mean either the "action of substituting one thing for another" or "succession of one thing in place of another", or the "action or process of making or becoming different; alteration, variation." [253] In other words, sociotechnical change means that some technology or its related practices are replaced, or that they become different. The old sociotechnical situation can disappear altogether, or the situation can change due to the addition of new technology and its uses. Technological development can also lead to new ways of using old technology, which similarly can be regarded as sociotechnical change.[254]

This leaves open, however, what kind of evidence[255] is required of sociotechnical change. In a way, of course, sociotechnical change is occurring constantly, causing a persistent stream of evidence. Additionally, many technologies fail to gain prominence because of technical, social, or economic factors, which means that the change is not linear.[256] Simultaneously, as noted above, law is generally slow in its developments: on the side of written law, which is under focus here, drafting and enacting legislation is obviously a lengthy process.[257] Together, these things suggest that law is not interested in reacting to every aspect of the constantly evolving sociotechnical landscape but rather to clearly distinguishable changes that actually have the potential to be significant. In considering the existence of sociotechnical change, therefore, we require evidence of change that is clearly distinguishable and meaningful. Not every branch of innovation needs to be considered from a legislative viewpoint.

251 Bijker & Law 1992. See also, *e.g.*, Pinch & Bijker 1984; Law & Bijker 1992; Bijker 1995.

252 See Bennett Moses 2013b; 2017.

253 *Oxford English Dictionary Online*, "change, *n.*", meanings I.3.a and II.12.a.

254 This is a simplification. For a more elaborate account on the meaning of change in the technological or sociotechnical landscape, see, *e.g.*, Parayil 2002; Rip & Kemp 1998, pp. 346–372.

255 I use the concept of evidence here in its general sense, not in the sense of evidence in judicial activity.

256 Pinch & Bijker 1984, pp. 405–406 (cit. Staudenmaier 1983/1984); Bijker & Law 1992, pp. 3–4.

257 There are simply too many variables (*inter alia*, the jurisdiction, type of legislative instrument, and drafting procedure) to take into account in order to provide any generalized data on this.

Another point to make is that the evidence we are looking for is primarily factual. By this, I mean that sociotechnical change is demonstrated by facts about technology and its related practices. To be sure, a change is not occurring simply because we can point out a disconnection between law and facts[258] or because there are legislative projects going on. The observation of legal disconnection and the ensuing legislative action are rather the *result* of there being a change. The facts that demonstrate a sociotechnical change generally concern, first, the characteristics of certain new technologies and, second, how existing or new technologies are or will be used.[259]

The concept of sociotechnical change simultaneously is separate from and part of social change. On one hand, sociotechnical change involves the distinct element of technology: as defined above, it has something to do with tools, techniques, processes, etc. that extend human capabilities. Perhaps social change cannot occur wholly detached from technology,[260] and in many cases the most major changes—changes from a particular social system to another—are connected to technology. Still, change that is not driven by or focused on technology is possible. Human history provides many examples of this, including changes in the various components that make up societies. For instance, a new election cycle may usher in a different public opinion about welfare, a religious reformation can change people's perception of the role of church, or a demographic shift can alter the power of societal groups vis-à-vis each other.[261] These types of changes can cause all sorts of legal issues and responses,[262] but they cannot always and necessarily be characterized as sociotechnical changes.

However, as noted, sociotechnical change is in many cases connected to general societal changes, and conceptually it can be viewed as falling within the ambit of such.[263] For instance, sociotechnical change in civil aviation to incorporate unmanned aviation can be regarded as part of a social change in how humans move and perceive mobility. In this way, examining law and sociotechnical change can be framed as part of law and social change, albeit this study only examines the former relationship.

Pursuant to the model developed in this Chapter, it is important to realize that mistakes in recognizing sociotechnical change can easily occur. In some cases, the existence of sociotechnical change can be mistaken as there being no such change;

258 See Brownsword 2008, pp. 161–167.

259 For an example of such assessments, see, *e.g.*, Bijker 1995.

260 Ellul 1964, p. 334 ("*all social changes, are located wholly within this condition of fact* ['technical forces and economic considerations beyond the reach of man'] unless they are purely utopian."). This is a deterministic objection to pure technological instrumentalism, according to which humans have full control over technology.

261 For a comprehensive, descriptive overview of humankind's social changes, see Chase-Dunn & Lerro 2014/2016. For a theoretical overview, see Form & Wilterdink (undated). The latter authors summarize several key theories on social change, including for example Auguste Comte's law of three stages (see Comte 1853).

262 For an overview of law's relationship with social change, see Roach Anleu 2000/2010.

263 Schwartz Cowan 1987/2012, p. 253.

in other cases, it might be thought that a change is occurring although, in reality, it is not. Our perception of this is affected by great many factors, as the model notes. Two important factors are our values and the public opinion, in that conservative estimates may downplay and liberal ones may exaggerate the change, or vice versa.[264] Another one is existing law due to the reciprocal relationship between law and technology.

Mistakes in recognizing change can particularly happen in the early phases of a particular new technology, as its implications on the overall sociotechnical landscape are unclear. A false perception might be formed due to miscalculations of effects by experts, due to political pressures by the general public, or due to values in the form of political standpoints. To this issue, though, there is no other fix but to call for the careful assessment of the facts at hand. The issue relates to the classical Collingridge dilemma,[265] or the uncertainty paradox: legislators must respond without having much information about the risks and without knowing how the technology will further be developed.[266]

3.1.2. Considering Legislation

The uncertainty paradox becomes more pronounced when we consider the appropriate responses to there being a sociotechnical change, or there being none. The appropriate response to there being no change (whether this actually is the case or not) is, of course, passivity. As is explained below, this approach simply means taking no legislative action, although judicial, administrative, or other responses can still occur. Of course, the legislators may still be instigated to act if some stakeholders exert pressure on them. In these cases, the problem might be that citizens mistakenly believe that a change is occurring, or that there is a pressure to address perceived sociotechnical problems albeit it is uncertain whether a change is occurring. In this manner, despite there being no sociotechnical change, legislation might still have to be considered in more detail.

When it is determined that a sociotechnical change *is* taking place, the preliminary question is whether there are existing rules that do or could apply to the new technology and its use. This does not mean that there should be rules to cover every aspect of the sociotechnical change; instead, it means whether there are any rules that apply, or *de lege ferenda*, could be applied to a particular aspect of the sociotechnical change. Such aspects include, most notably, the desired characteristics or intended manner of using of the new technology. The standard as to what constitutes rules that "could apply" is loose and difficult to define. Existing studies use a threshold of

264 Since these factors are not the centerpiece of the model, I have taken the liberty to generalize, instead of presenting in perfect scholarly fashion, the viewpoints that might come into play. The concepts of "conservative" and "liberal" are thus used purely in an illustrative manner.

265 Collingridge 1980, p. 11.

266 Asselt, Vos & Fox 2010.

"clearly connected",[267] which could be downplayed to simply "connected" or "related". Regardless, the exercise in defining connected rules should not be emphasized over the more important ones: recognizing and responding to the possible legal problems caused by them.

If there are no rules that apply or could apply, then there is vacuity: a lack of applicable rules. Perhaps the change should be legislated, but nothing in the present law is there to guide the way. In such a case, the only option is to move directly onto considering legislative action. The situation of there being no rules at all is framed below as an issue in slightly more detail.

The following questions in the process leave aside the lack of applicable rules, instead focusing on the use of existing rules. This leads us to question whether there are or would be any issues with their application. When there are no issues with their application, we move to consider what legislative action should be taken. If there are or would be issues in application, we move onto recognize which of the issues we are dealing with. The application of a particular rule may cause one or more issues, depending on what the rule states and what the sociotechnical change entails. These are all causes for legislative action. The typology of the issues, as the following section describes, largely draws on existing legal scholarship but equally makes some changes thereto. Chapter 4 exemplifies the meaning of the issues in the case of drones.

Finally, the model identifies five legislative approaches that can be taken as a response to sociotechnical change. First, it is always possible to remain passive. In addition, though, it is possible to replicate or emulate the content of existing rules in new rules that apply to the new technology or its use. The assumption is that there has already been a thorough consideration of the issues with the application of current rules, so reverting back to the "issue loop" is not necessary. Additionally, there is an option to enact alternative rules that introduce new concepts, standards, and procedures. Finally, there is transformation, which signifies that the existing rules should be changed. The meaning of these approaches is explained in this Chapter in abstract and exemplified in Chapter 5 with reference to drones.

The choice among the approaches is affected by several factors, for instance the problems in existing rules, and practical aspects and values. Practical aspects include things like financial resources that are required in the legislative project. Values, on the other hand, might affect the choice of approach in that a conservative attitude[268] by the legislator or important stakeholders may prevent adopting alternative rules or transforming existing ones. Of course, there are numerous values, such as sustainability, human welfare, security, and biodiversity that can affect the choice in all sorts of ways.

267 Bennett Moses 2007b, p. 260.

268 Again, this concept is used purely in an illustrative sense.

There are some natural pathways between the identified issues (or lack thereof) and the legislative approaches. For example, passivity is the most prominent choice when there are no issues in letting existing rules apply without any legislative action, but it may also be resorted to when there is a cause to ignore the issue(s). Replication or emulation will be used when it is necessary to expressly affirm the application of existing rules. On the other hand, if there are no applicable rules, the approach has to involve either drafting alternative ones or altering the scope of existing ones. Despite these connections, the primary aim of the model in its current form is to merely categorize, not to suggest a particular response to a particular problem. Creating clearer pathways can be seen as an opportunity for future studies.

3.2. Legal Issues Caused by Sociotechnical Change

3.2.1. Disconnection and Disruption

Literature noting the lasting conflict between law and technology (or science) is vast. As hinted above in the discussion on the law and technology enterprise, the observation that law lags behind scientific or technological progress is a commonplace one. It is repeated in many legal articles dealing with some kind of new technology or its use,[269] and most of the articles of this study as well as this synthesis similarly hint at it.[270] The observation is contestable because it does not seem to recognize the reciprocal relationship between law and technology. This study, however, is not interested so much in the observation alone but typologies and theories on the exact kind of legal issues following from sociotechnical change and existing law. Such have been presented during the past few decades by several authors.[271]

A very general way of framing the issue is the concept of disconnection, as theorized by Roger Brownsword on the basis of John Barlow's idea. Disconnection, which could also be referred to as dissymmetry,[272] simply means that there is a mismatch between law and technology. Technology often progresses fast and in leaps while law through small increments, which causes the latter to be left behind. New technology might also be controversial or unexpected and already in circulation when consensus opinion is yet to be formed. Disconnection is usually most obvious before there is an idea of how to regulate the new technology, but it may also present itself when

269 *E.g.*, Moses 2007b, p. 241.
270 See Huttunen 2017, pp. 350–351; 2019a, pp. 71–72; 2019c, pp. 85–86.
271 Scholars have exemplified the problems with cases from a wide range of topics, including the railroad, printing press, computer software, the internet, online shopping, state investigative searches, surveillance technology, *in vitro* fertilization, DNA profiling, artificial intelligence, nanotechnology, and cloning. See, *e.g.*, Bennett Moses 2003; Brownsword 2008; Cockfield 2004, pp. 388–398; Cockfield & Pridmore 2007, pp. 505–512; Drahos 1985; Friedman 2001, pp. 75–84; Matwyshyn 2007, pp. 519–530.
272 Askland 2011, p. xix.

the regulatory process is on its way and, of course, when the new rules have been adopted.[273]

Civil UAS could be described as a disruptive innovation, a term introduced by Joseph L. Bower and Clayton M. Christensen. This means that drones introduce into civil aviation characteristics that differ from the ones of manned aircraft, as traditionally valued by the industry. In terms of, for instance, flight duration, air speed, and capacity, drones perform worse than manned aircraft, for which reason traditional key applications like air transport have been out of question for drones. The use of drones has indeed focused on new applications, as listed above. As drones establish themselves in such applications, sustaining innovation can lead to their wide acceptance in traditional applications, too.[274] Since Bower and Christensen's recommendations on dealing with disruptive innovation are aimed at businesses rather than legislators, they are not discussed in this study any further.[275]

Furthermore, a single technology is usually insufficient in truly disrupting a whole field of activity: disruption rather occurs when the world is introduced a cluster of technologies and technological practices.[276] To apply the idea to this study, the fact that an aircraft is piloted from outside the aircraft is by itself not the most profound challenge to civil aviation. The disruption, if such is occurring, takes place in conjunction with other changes: the automatization of air traffic management, the cheapening of technology (resulting in drones), the increasing use of electric engines, the increased potential of using of mobile devices in aviation (to, *e.g.*, plan flights or order an air taxi), resulting in increased accessibility. This study hence does not claim that drones alone are disrupting the civil aviation industry. The point is instead to identify the kind of legal problems they have created and to see whether these match with the problems previously identified in legal scholarship.

3.2.2. Four Reasons for Legal Change

The typology of legal issues caused by sociotechnical change, which is employed in this study, is based on the one introduced by Lyria Bennett Moses. The reason for choosing this particular typology as a basis is simply that, to my knowledge, it offers the most elaborate construction of the given issues to date. It explicitly seeks to distinguish the types of problems in a systematic manner and illustrates the problems by referring to real life examples. Bennett Moses's work is also valuable because it

273 Brownsword 2008, pp. 160–166 (cit. Barlow 1994). See also Mandel & Marchant 2013, pp. 26 and 31.

274 See Bower & Christensen 1995, pp. 45–47; Christensen 1997/2000. See also Brownsword, Scotford & Yeung 2017, pp. 7–14. In the context of drones, see Masutti & Tomasello 2018, pp. 7–20.

275 The third article of this study (pp. 15–16) does refer to drones as disruptive technology, but this is not intended as an argumentative point for the purposes of applying Bower & Christensen's theoretical model.

276 Tranter 2017, pp. 6–7.

seeks to address certain fundamental questions that the use of such typologies can entail, including for instance the meaning of technology and the distinctiveness of technology-related (sociotechnical) problems.[277] The typology, which she has rather uniformly applied throughout several years of academic writing, identifies

> four main reasons why advocates may urge legal change as a response to technological change, namely:
> (A) The Need for Special Laws ...
> (B) Uncertainty ...
> (C) Over-inclusiveness and Under-inclusiveness ...
> (D) Obsolescence.[278]

The meaning of these reasons may seem quite self-explanatory but ultimately is not. According to the author, the first refers to the resolving of a conflict between sociotechnical change and social, environmental, and cultural values. Through the introduction of new technology and its related practices, there may be a need for laws to ban, restrict, or, alternatively, encourage the new forms of conduct. In Bennett Moses's typology, this refers to new laws that are tailored particularly for the new technology. To provide examples, the author refers to railroad networks, *in vitro* fertilization, and the internet, which all raised concerns about the sufficiency of existing law.[279]

Technical uncertainty, as mentioned by another author, is about the unknown benefits and risks of innovations.[280] Legal uncertainty, which Bennett Moses refers to, means that there are ambiguities about the scope of existing categories and the meaning of concepts. Rules might authorize the sociotechnical change or restrict or prohibit it; the legal consequences of the conduct are unclear. Consensus among experts may be lacking about the given issues, usually because there are authoritative contradictory arguments. While language is inherently vague, according to the author, uncertainty about future sociotechnical change is the kind of vagueness that cannot be reduced when a law is enacted. This is because such change introduces new, sometimes unimaginably new entities. This uncertainty is also different from regular uncertainties in legal practice, such as determining what has happened in a particular case.[281]

In this regard, too, Bennett Moses uses the railroad as an example, given the past issue in some countries about whether it should be regarded as a public thoroughfare

277 Bennett Moses 2007b, pp. 243–247; 2013b, p. 10 *et seq*.

278 Bennett Moses 2007b, p. 248 (footnote excluded). See also Bennett Moses 2003, pp. 396–401; 2005, p. 507; 2007a, p. 599; 2011a, p. 767; 2011b, p. 77; 2013b, p. 7.

279 Bennett Moses 2007b, pp. 248–250 (cit., *e.g.*, Bernstein 2002; Ely 2001; Friedman 1986).

280 Abbott 2011, p. 133.

281 Bennett Moses 2007b, pp. 250–253 and 257–258. See also Mandel & Marchant 2013, p. 17.

or private property. However, she also refers to rules on discovery whose application to electronic data was uncertain in the early days of computers. Uncertainty may equally materialize in the opposite way. This is the case when sociotechnical change causes ambiguity in existing categories and concepts, as was the situation with the concept of motherhood in the case of *in vitro* fertilization.[282]

Legal uncertainty has previously been recognized as an issue by, for example, Peter Drahos. He called it invariance (asymmetry) between legal rules and particular facts introduced by new technology. He distinguished two types of the given problem. On one hand, no legal rules might obviously apply to the new facts. This calls for completely new rules to govern them. On the other hand, rules might apply to the facts but lead to uncertainty or an outright undesirable result. In such cases, the author notes, criticisms of law as being silent, uncertain, inappropriate, or wrong are common.[283] More recently, Roger Brownsword has dubbed the issue as descriptive disconnection, in which case the descriptions employed by regulations do not correspond with the new technology or its use.[284] Uncertainty has been elaborated on by other authors, too. One of Gregory Mandel's key insights about law and technology is that existing legal categories may not suit legal issues regarding new technology.[285]

As noticed by Michael Kirby in 1977, existing laws may become counterproductive through scientific and technological developments.[286] Bennett Moses's typology refers to this problem as over- and under-inclusiveness, which concern the purpose (objective, goal) of rules. Over-inclusiveness occurs when the rule applies to some circumstance although the application goes against or does not advance the purpose of the rule; under-inclusiveness occurs when the rule does not apply to some circumstance although the application would be in accordance with or advance the purpose. In both situations, the application unintendedly targets or fails to target the new technology or its use. Hence, rules are "targeted" to the extent they are designed to fulfill a certain goal and avoid over- or under-inclusiveness.[287]

The often-unforeseeable nature of sociotechnical change makes the inclusiveness issue distinct from targeting challenges that arise when legislation is drafted. In the latter case, the problem is the persistent issue of how to enact rules that achieve their goals (have an appropriate scope) in the *present* situation. This is not obvious,

282 Bennett Moses 2007b, pp. 253–257 (cit., *e.g.*, Redfield 1858, pp. 1–2; Schweber 2004; *Alton & Sangamon Railroad Company v. Baugh; Davis v. Davis; Hemingway v. Fernandes*; *National Union Electric Corporation v. Matsushita Electric Industrial Company*).

283 Drahos 1985, pp. 279–280.

284 Brownsword 2008, p. 166.

285 Mandel 2017, pp. 227–234.

286 Kirby 1977, p. 3.

287 Bennett Moses 2007b, pp. 258–264. Over- and under-inclusiveness could also be framed as inconsistency. See Kaal & Vermeulen 2017, p. 184.

since there are factors such as disobedience and activities in other spheres of life that reduce the probability of the rule meeting its goal. Furthermore, there are other considerations in drafting rules, such as the simplicity of rules as well as the total number of rules and institutions applying them. In the case of sociotechnical change, the distinct problem is that, at the time of drafting, it cannot be known what kind of rules would have the appropriate scope in the *future* sociotechnical situation.[288]

As one example of over-inclusiveness, Bennett Moses points out how the obligation of common carriers to make a delivery of goods to the premises of the recipient was over-inclusive in the context of railroad cargo. Railroad stations, after all, are not commonly located at the premises of citizens. The examples on under-inclusiveness are somewhat more complex. For example, the author notes that some United States legislation on disabilities does not (at least did not as of 2007) protect against discrimination that is based on information about a person's genetic propensity to develop a particular disease before any symptoms occur. Such information has only become available through genetic testing, which represents sociotechnical change.[289]

Obsolescence is another way of saying that existing rules are outmoded or irrelevant.[290] As noted by Friedman and since elaborated on by Bennett Moses, in the context of sociotechnical change this means three things. First, such change may reduce the importance of conduct that has thus far been regulated. If some activity, like the recording of music at home using tapes, is no longer practiced because of sociotechnical change involving the internet, the rules governing it become irrelevant. Often, sociotechnical change enables some form of conduct that replaces the old one. This does not always mean that the rules should be repealed, but some legislative response may be necessary. The second case of obsolescence is about cost-effectiveness: rules can become redundant if their enforcement is no longer worth the trouble. For example, traditional laws on sports doping can become useless if undetectable drugs are developed, and it has been claimed that traditional copyright laws have become expensive to enforce because of the Internet.[291]

Third, technological change may question whether some rules are justified. According to Bennett Moses's first formulation, "the invention and diffusion of new technologies may change the underlying facts that had justified some legal rules".[292]

---

288 Bennett Moses 2007b, pp. 258–260 and 264 (cit., *e.g.*, Diver 1983; Ehrlich & Posner 1974; Posner 1990; Schauer 1991; Schuck 2000).

289 Bennett Moses 2007b, pp. 261–262 (cit., *e.g.*, *Code of Laws of the United States of America*, Title 42; *Bragdon v. Abbott*; *Sutton v. United Air Lines;* Ely 2001, p. 182).

290 Kirby 1977, p. 3. See generally Calabresi 1982 (arguing that judges should be allowed to deviate from obsolete legislation); Gilmore 1967.

291 Bennett Moses 2007b, pp. 264–266 and 268–269 (cit., *e.g.*, Galluzzi 2000; Melville 2001); Friedman 2001. Please note that I have reversed the order of the cases presented by Bennett Moses.

292 Bennett Moses 2007b, p. 265.

Later, she redefines the crux of this issue as follows: rules become obsolete when the goal they were meant to serve becomes redundant. To this end, three examples are given. The first example refers to an arcane Californian provision about the presumption of fatherhood, the purpose of which was to avoid speculation in that regard in convoluted cases and to protect the institution of marriage. Blood and DNA tests have made it redundant to follow the rule anymore. The second case refers to exclusive rights to certain radio frequencies, granted by states in order to avoid interference. There are techniques allowing the sharing of the frequencies, which undermines the justification for such grants. The third example goes as follows: In order to promote the rights of cattle drovers, some states had laws requiring landowners to erect high and sturdy fences if they wished to seek compensation for damage caused by roaming cattle. Since such fences were expensive to build, virtually no one did so, which benefited the drovers. The introduction of barbed wire made such laws obsolete, which in turn benefited the farmers.[293]

3.2.3. Developing the Typology

There are several ways in which the model of legislation and sociotechnical change developed in this study attempts to improve the coherence of Bennett Moses's typology. Overall, the improvements concern the delimitation and terminology of the legal issues. The first problem to be addressed is the need for special laws. This concept does not appear to be a primary problem on its own; it arises when a problem with current law occurs. There may be a need for special law when there are no applicable rules but possibly also when the present rules are problematic to apply. It is a call to consider future legislation: the kind of "second level" issue to which Kenneth Abbott has referred to as political uncertainty.[294] Indeed, Bennett Moses's discussion on the need for special laws focuses on the solutions to whatever problems may arise out of sociotechnical change.[295] Yet questions relating to solutions can hardly be grasped as merely the need for special laws, since there are other options available, such as emulating existing rules or changing the rules altogether. This is why there does not seem much of a reason in trying to spot where there is a need for special laws.

The problem with the concept of uncertainty is trying to grasp exactly what kind of uncertainty it refers to. Bennett Moses's typology has rather a specific kind of uncertainty in mind, as it focuses on the problem of classifying new technologies and related activities pursuant to existing categories: that there are ambiguities about the scope of concepts in relation to new technology or its use. On the other hand, new technology may challenge existing categories. However, on the face of it,

293 Ibid., pp. 266–268 (cit., *e.g.*, Calabresi 1982, p. 244; Singer 2006; Werbach 2004).

294 Abbott 2011, p. 134.

295 Bennett Moses 2007b, pp. 249–250.

uncertainty is more of a meta level issue that permeates the whole scope of assessing sociotechnical change: there are uncertainties in all stages of the process of legislating sociotechnical change.

One could designate the problem as "ambiguity", but this seems even more misleading than "uncertainty". Ultimately, though, the problem that some aspects of sociotechnical change do not find their place in existing concepts seems merely a preliminary issue. The actual problem that legislation has to address is the risk of wrongly classifying some aspects of sociotechnical change as something they are not, which may lead to erroneous results. This is what we must avoid if we are to appropriately deal with new technology and its use. Hence, the problem of uncertainty is here reframed as one of *misclassification*. Misclassification includes cases in which existing categories wrongly classify some aspects of the changed sociotechnical situation. If the existing categories appear problematic altogether due to sociotechnical change, instead of uncertainty the problem is the irrelevance or ineffectiveness of such categories, as described below.

The model developed here regards over- and under-inclusiveness in their original formulation as unproblematic concepts. They well encapsulate the idea that sometimes rules inappropriately exclude or include behavior. The inappropriateness has to do with the purpose of the rules, which in both cases is violated. At first, it may appear odd that under-inclusiveness is presented as an issue with the application of existing rules. After all, in that case rules do *not* apply to behavior they should apply to. However, under-inclusiveness does not really describe situations in which there are no rules at all. Rather, it concerns cases in which there are connected rules that could apply to some aspects of the sociotechnical change but, for one reason or another, are targeted so that they do not. Hence, it makes more sense to describe it as a problem with applying related existing rules instead of a problem of there being no rules at all.

An aspect of the original typology that could be regarded as problematic is that it offers three forms of obsolescence rather than explores these issues as unique problems. While the distinctions appear clear, it might be useful to emphasize them. The characterizations of the "sub-issues" could also be altered to some extent.

The first form of obsolescence is that the conduct targeted by certain existing rule(s) has become less important. The lessened importance of particular conduct itself is not, as Bennett Moses herself acknowledges, much of an issue. However, rules that focus on the past situation can, due to sociotechnical change, lead to unexpected consequences[296] or make it difficult to understand law.[297] While this problem can be characterized as obsolescence, the present study calls it *irrelevance*:

296 This relates to the discussion on the concept of desuetude (in domestic law). See, *e.g.*, Bonfield 1964; Calabresi 1982, pp. 17–24.

297 On legal complexity in general, see, *e.g.*, Schuck 2000, pp. 3–46.

the rules in question have become irrelevant (and thus possibly obstructive) in the new sociotechnical situation.

The second form refers to cases in which sociotechnical change has reduced the cost-effectiveness of (enforcing) existing rules. On the other hand, it is characterized as the rules having become difficult to enforce. In most cases, one aspect of the problem is indeed that the costs of enforcing the rules are in mismatch with the probable results. One of Bennett Moses's examples concerns drug testing. If new, undetectable methods of doping are developed, continuing testing by existing rules is, to an extent, a waste of resources. However, it would seem that the cost is not the main issue here; instead, the problem is that doping athletes might slip through the system and compete. This goes against the purpose of anti-doping rules, which is to guarantee the integrity of competitive sport. The problem is thus that rules may become *ineffective* in advancing their purpose.[298]

Ineffectiveness is rather similar to under-inclusiveness. In both cases, the present rules in some way fall short of dealing with the sociotechnical change. However, in under-inclusiveness the problem is more that the new technology or its use fall categorically outside the scope of the existing rules. This is a targeting issue. Meanwhile, if existing rules are ineffective, the sociotechnical change, like new doping methods, does fall under the scope of the rules. The problem is, though, that enforcing the rules does not produce the expected effects.

The third form of obsolescence was originally defined as follows: rules become obsolete when their goals become redundant. It is quite rare, however, that the very purpose of a rule becomes redundant. This is because the goals of rules often represent deeply embedded values, which could be defined as criteria of desirability or of preference.[299] Values are certainly debatable but can hardly ever be entirely regarded as obsolete.[300] A much more common case is that rules become obsolete when they advance their purpose in an unjust manner: as a result of sociotechnical change, there is some form of *injustice*. Such a notion comes closer to Bennett Moses's original formulation, which referred to sociotechnical change changing the underlying facts that justify a rule.

The examples provided by Bennett Moses testify to this. In the case of paternity testing, the goal of the laws (avoiding speculation, protecting marriage) has never become obsolete. It is just that the method of asking about impotency or cohabitation may have become unjust because the blood or DNA of the persons can be used to provide a more reliable result to determine paternity. The pre-existing rules have

298 Meanwhile, if procedures of existing law (would) impose too heavy costs or requirements on the new technology, the issue is better characterized as over-inclusiveness.

299 Williams 1967; 1977.

300 Williams 1967, p. 29 ("Although extremely rare, there are some instances in which there is a quick extinction of a previously accepted value."). Williams is, however, referring to a situation where the examined population no longer accepts the value; as an abstraction, the value still remains a possibility.

become ineffective but also unjust, since they are unreliable and require extraneous inquiries into people's lives. Similarly, the prevention of interference in the case of radio communication has not become a redundant goal. Instead, achieving it through exclusive frequency rights may have become unjust due to techniques allowing the sharing of the frequencies.

The example of barbed wire is, however, different from the other two. The problem with barbed wire was not that it made the purpose of the fence laws (promotion of cattle droving) obsolete. Nor was it so that because of barbed wire the fence laws pursued their purpose in an unjust manner. The obligation to build sturdy fences to seek compensation had not become unjust; it was simply that farmers could ignore the obligation altogether and never seek redress because barbed wire would protect their land. The fence laws had thus become obsolete in the sense of irrelevance: they targeted the preceding sociotechnical situation in which there was no barbed wire. The rules could be upheld or repealed: the original issue was no longer at stake.

3.2.4. Other Issues

The example of barbed wire is useful since it provides a segue to other issues. In the preceding section, I argued that the introduction of barbed wire made old rules on fences irrelevant. Independent of this irrelevance, however, barbed wire can be said to have had a distinct effect: its introduction challenged the value of droving and possibly other matters vis-à-vis land ownership. If the use of such wire is allowed, land ownership is valued; accordingly, forbidding it may emphasize the value of droving or wildlife.

This brings us to cases in which there is a possibility that the purpose of an existing rule—its key value—is challenged by sociotechnical change. Such situations often work in two directions. Not only might sociotechnical change challenge values but, on the basis of the purposes of some rules (values), we might question the sociotechnical change itself. The issue could be summed up as being one of *value conflict*. This issue is actually discussed by Bennett Moses in the context of the need for special laws. She refers to, *inter alia*, how railroad networks caused social disruption,[301] which according to my interpretation signified a move toward weakening the then established, rather sedentary way of life. It resembles Brownsword's concept of normative disconnection by which he refers to the case in which new technology and its use raise doubts about the values of the existing regulatory framework.[302]

From one perspective, a clash between values is already included in over- or under-inclusiveness. Inclusiveness, after all, goes back to the purpose of the rules, which are linked with values—in some cases clearly, in others more tediously. Over-

301 Bennett Moses 2007b, pp. 248–249 (cit., *e.g.*, Ely 2001). See also Bennett Moses 2013a, p. 39.

302 Brownsword 2008, p. 166. See also McMillan & Snelling 2017.

and under-inclusiveness are not defined, however, so that the sociotechnical change would challenge the very purpose of the rules. For example, the purpose of the obligation to deliver goods to the premises of recipients was (probably) to ensure that the goods are not stolen and remain unharmed. The introduction of railroad shipping did not challenge this purpose, as goods shipped on trains should not be stolen or harmed either. To be sure, neither did it mean that the existing rule had become unjust in general. Goods were and are still being shipped by methods that necessitate a delivery on premises. The legislator would simply have to come up with rules that would fulfill the same purpose and thus uphold the value in a manner feasible for railroad shipping. A conflict of values is thus an issue that cannot be fully subsumed under the other issues.

The model developed here specifies the meaning of value conflict to two issues: how the values of existing rules can make sociotechnical change appear unacceptable, and how sociotechnical change can make the values of prevailing rules appear unacceptable. The conflict is a legal issue when the values are, in one way or another, embedded in law. As with over- and under-inclusiveness, this requires looking into the purpose of the rules. Beyond law, value conflict falls within the ambit of politics and ethics, though both of these are themselves closely linked to law.

Despite such a definition, value conflict remains rather an ambiguous issue. Overall, quite like uncertainty in its broad meaning, it is something that permeates the whole relationship between law and technology. Indeed, it permeates the whole relationship between technology and society.[303] Value conflict appears to be the fundamental problem that, according to Tranter, the law and technology enterprise commonly ignores.[304] Abbott refers to it as normative uncertainty, the difficulty in reconciling technology with values or social norms,[305] though this appears to blend together with the aforementioned notion of legal uncertainty.

Still, as Bennett Moses herself has later noted, values and their priority are nearly always changing and contested.[306] As suggested by social studies, values can lose their importance, become limited by other values, or become the centrepiece of a society.[307] Such plurality of values makes it easy to display the existence of a conflict between certain values and certain sociotechnical change. But, because of the general disagreement in societies on which values matter, a value conflict may be hard to claim as a cause for a particular legal response.

Finally, I am obliged point out that the original typology seems to be missing one issue, as mentioned above: *vacuity*, which means there are no applicable rules. To

303 On technology and society in general, see the discussion above and, *e.g.*, Ellul 1964; Heidegger 1954/1977; Schön 1967; Winner 1978.

304 Tranter 2011a, p. 70.

305 Abbott 2011, pp. 133–134.

306 Bennett Moses 2013a, p. 39.

307 Williams 1967, pp. 29–30.

be sure, a complete lack of rules that somehow concern a situation is quite rare. In modern law, there are usually some rules that do apply to the changed sociotechnical situation. These may either stem from the preceding sociotechnical situation, but they also include general principles of law, human rights, constitutional provisions, and so forth. Naturally, the extent to which these rules are connected to the matter at hand can be contested. In addition, it is not unheard of that at least certain aspects of new technology do not fall under existing law. This is something that any theory of law and sociotechnical change should recognize as an issue.

3.3. Legislative Approaches to the Issues

3.3.1. Passivity

There are several ways to perceive how a legal system reacts to legal problems caused by sociotechnical change. These typologies discuss the issue identified by Bennett Moses as the "need for special laws"[308] but also the use of and changes to existing law. On one hand, the existing typologies are extremely broad. They focus on, *inter alia*, whether regulation or governance is necessary, what kind of regulation can or should be pursued, and when can or should the regulators react. On the other hand, in terms of legislative approaches, the typologies are quite narrow: they do not comprehensively recognize all the different ways in which written law can respond to sociotechnical change. A distinct issue is that the theories are not fully commensurable since they arrive at their description, explanation, or normative argument from slightly different viewpoints.

For the given reasons, this study introduces a new typology of five approaches to describe legislative responses to sociotechnical change. The typology partly draws upon existing theoretical development but mostly employs its own terminology. The approaches identified by the typology are passivity, replication, emulation, alternative rules, and transformation. This section introduces the typology in its subsections, and the following section will contextualize it, examining its relationship with existing literature on technology governance. Applying the typology to drones will take place in Chapter 5 of the study, and the Conclusions will address some problems with the typology.

Passivity[309] is the simplest of the five approaches, as it means taking no action to legislate sociotechnical change. This means passivity from the standpoint of written law: judicial or administrative response, which are not addressed here, can still occur. A group of authors discussing foresight in regulation has previously

308 *E.g.*, Bennett Moses 2007b, p. 248.

309 I would like to thank my colleague Juhana Riekkinen for pointing this out.

called it the strata of status quo.[310] Indeed, not taking any regulatory action is the default state of things: enacting rules requires human effort. As long as prevalent rules are able to fulfill their desired goals as they are, there is no need to imagine issues to regulate. In other words, passivity works when existing rules accommodate the change adequately without any action.[311] Passivity is typically invisible. It only becomes visible once there is a shift in reality, a sociotechnical change in this case, which necessitates action or non-action. However, the mere recognition of passivity is not usually sufficient to abrupt it. The necessary impetus for action is social pressure. To quote Lyria Bennett Moses,

> inertia is usually only overcome in response to actual events that generate a degree of community or interest group pressure.[312]

Passivity can either be a conscious approach or reflect the unwillingness, inability, or apathy of the legislator, or exist as an intermediate space. By the first, I refer to the case in which the legislator explicitly deems it unnecessary to legislate a particular sociotechnical change. As a conscious approach, passivity resembles Brownsword's notion of unproductive disconnection. This refers to a case in which new technology and its use clearly fall within the intended scope of the regulatory framework, thus making it unproductive to use resources to re-establish the scope for the new technology. In other words, it would be of little to no use to enact new rules that would simply restate that the existing standards apply to the new phenomenon.[313]

By inability, I refer to cases in which the legislator does not know how to legislate a sociotechnical change. This kind of passivity is usually of intermediate nature, as it takes time for the legislator to understand the new phenomenon and come up with an appropriate active approach (as explained below) or continue with passivity as a conscious approach. Although the present typology does not address the timing of legislative action itself, it is worth pointing out its connection to passivity: sometimes taking legislative action would be too early (or too late), disrupting the development of the technology.[314] Despite this danger, in the long run passivity is often an untenable solution.

---

310 Laurie, Harmon & Arzuaga 2012, p. 24.

311 See ibid.

312 Bennett Moses 2003, p. 407. See also Laurie, Harmon & Arzuaga 2012, p. 24.

313 See Brownsword 2008, pp. 166–167. Productive disconnection, meanwhile, is related to the four other approaches, as in that case "it is entirely appropriate that regulatory resource should be committed to further debate and decision concerning the new technology." (Ibid., p. 167.).

314 See below.

3.3.2. Replication and Emulation

Another legislative approach is replication. In replication, the legislator issues a rule stating that the new technology and its use must follow the rules that have existed prior to the sociotechnical change. In other words, the legislator extends the scope of existing rules and instruments to cover the changed sociotechnical situation. It is simply stated that an existing legal instrument or a rule must be followed, or that the technology or its use falls within the ambit of a certain instrument. Friedman's and Kahn's observations about the legal system dealing with new technology under existing rules[315] is relevant here, since replication requires the minimum legislative effort, going beyond mere passivity. To borrow from Elen Stokes, it is about the continued application of inherited legislation, which has been designed for conventional technology.[316] Replication is the obvious option when there are no apparent issues with the old rules.

Replication, as a legislative approach, does not refer to the application of rules by courts. Hence, it is not about courts applying old rules as they are to the new technology; instead, it is about legislators issuing rules or recommendations that require following existing provisions. In legislating civil drones, as is the focus of this study, replication means rules that directly copy the content of existing safety or security standards.

Replication saves plenty of legislative effort and advances a continuum in the treatment of technologies. As Mandel has noted, handling disputes regarding new technology with existing rules is administratively the simplest approach. Existing frameworks are also often favored because of their familiarity. His main argument is, however, that disputes resulting from new technology are often unforeseeable, which can render the existing framework unusable.[317]

In the context of nanotechnology, it has been similarly noted that replication transmits the old substantive provisions to the new technology, and the old regime has its limits. Simultaneously, though, the traditions and assumptions about the values, objectives, priorities, and application of the provisions may be transferred. This can result in not only a mismatch but a misplaced opportunity to deliberate such assumptions as the new technology is being introduced.[318] The question is whether current legislation can deal with the sociotechnical change on a functional level, but also whether current legislation represents desirable values that should persist in the rules that follow.

Replication can be contrasted with emulation. With emulation, the sociotechnical change is legislated using existing rules or instruments but in a different manner. To

315 Friedman 2001, p. 73; Kahn 2016, pp. 1–2.
316 Stokes 2012, p. 99
317 Mandel 2017, pp. 238–243.
318 Stokes 2012, p. 101 *et seq*; Stokes & Bowman 2012, pp. 236 and 240–241.

generalize, new technology and its use are approached from the perspective of old technology and related practices, yet not simply by a requirement to follow existing rules. Rather, existing law serves as a basis for new concepts or procedures. In one sense, this is what David Friedman referred to as the modification of old rules to fit new technology;[319] Randolph Kahn called it "rounding edges".[320] Emulation attempts to make the most out of the rules there are without accepting all formulations in their original form.

Emulation involves more legislative effort than replication. Tailoring new rules on the basis of old ones to better fit the sociotechnical change consumes resources, depending on the amount of work needed. Still, it is less consuming than drafting alternative rules or transforming the existing ones. Furthermore, just like replication, emulation advances continuity in legislating technologies. This can, of course, be a negative aspect as continuity can also mean that the values, objectives, and priorities of existing rules persist to cover the changing situation.[321]

3.3.3. Alternative Rules

To tackle issues caused by sociotechnical change, sometimes it is necessary to create altogether alternative rules and instruments. Such rules may have been inspired by traditional legal mechanisms, but they do not attempt to replicate or emulate them. Instead, they introduce wholly new concepts, standards, and procedures into the system of law that is perceived as requiring additions. To be exact, we are not merely dealing with *new* rules;[322] after all, new rules can simply usher in replication or emulation. Alternative rules produce a *substantive difference* to the existing ones.

Alternative rules respond to Bennett Moses's notion of the need for special laws,[323] or as she has later called them, *sui generis* rules: rules of their own kind. By this, the author refers to narrow legal regimes which only target a particular entity, activity, or relationship, as opposed to a broad category thereof.[324] The idea is largely the same, although the concept of alternative rules—like the other approaches presented here—underlines the reactive part of the rules in relation to existing ones. Alternative rules differ from replication and emulation in which existing rules are relied on, but they also differ from transformation in which such rules are changed. In the context of civil aviation, alternative rules for drones are rules that are not based on the provisions of existing aviation safety and security law.

319 Friedman 2001, p. 73.

320 Kahn 2016, pp. 1–2.

321 Stokes 2012, p. 101 *et seq*; Stokes & Bowman 2012, pp. 236 and 240–241.

322 See Bennett Moses 2003, pp. 401 and 413–416; Friedman 2001, p. 73.

323 Bennett Moses 2007b, p. 248.

324 Bennett Moses 2011b, p. 78.

Alternative rules are also akin to what Elen Stokes and Diana Bowman have called regulatory adaptation, which pursuant to their description refers to the modification of existing regulations through specific provisions to better accommodate new technology.[325] Alternative rules, however, do not modify existing rules. Sometimes, they are not even placed in existing legislative instruments. New documents and instruments can be enacted specifically to address the new technology and its use. Both "adaptation" and "modification" could be read as representing emulation. Yet the authors use these terms clearly in the sense of enacting alternative rules, not in the sense of transferring existing provisions to cover new technology. Andrew Askland has explicitly mentioned "alternative legal structures and forms",[326] though the context does not reveal whether the reference is to alternative rules or transformation in the sense these approaches are developed here.

There are both advantages and disadvantages to creating alternative rules. Drawing upon Bennett Moses's discussion on *sui generis* rules, one can note that sometimes targeting rules at a particular entity, activity, or relationship is the only choice. This is so, among other circumstances, when one can convincingly argue that the new technology and its use are truly distinctive. Imposing the same rules on diverging technologies also bears uniformity costs.[327] One disadvantage is that establishing alternative rules, whose purpose may have been to fill a gap, can actually lead to incomplete legislation. As explained by Bennett Moses, serious issues may arise when it is decided that a particular new technology does not fall within existing rules, but the newly enacted rules fail to address some concerns.[328]

Another issue is that drafting rules, as opposed to replicating or emulating existing ones, is costly. Legislative procedures consume resources, which may seem questionable if the rules under development are not very broad in their scope. Requiring bureaus to enforce an alternative set of rules with regard to particular technology (or establishing new bureaus altogether) is equally time-consuming and expensive. Additionally, requiring all lawyers in the field to become familiar with the alternative rules will increase legal costs. Finally, alternative rules will probably cause new legal disputes to arise.[329]

Alternative rules, being a reaction to sociotechnical change, risk being too tied to a certain state of technology. If such is the case, future technology can cause a re-emergence of misclassification, over- or under-inclusiveness, ineffectiveness, or other problems, to employ the terminology of this study. The rules may distort the

325 Stokes & Bowman 2012, p. 237.

326 Askland 2011, p. xix.

327 Bennett Moses 2011b, pp. 81–83 (cit., *e.g.*, Annas, Glantz & Roche 1995; Carroll 2006; Samuelson 1986).

328 Bennett Moses 2011b, pp. 83–85 (cit., *e.g.*, Bennett Moses 2005; Kohler & Palmer 1998).

329 Bennett Moses 2011b, pp. 85–86 (cit., *e.g.*, Brownsword 2008, p. 152; Burk & Lemley 2003; Samuelson 1986, pp. 501–502).

development of future technology, too, given how law shapes technology. A distinct plausible issue is biased legislation, that is, legislation that favors some stakeholders over others. This results from the fact that narrowly applicable rules are more susceptible to the influence of individual stakeholders.[330]

3.3.4. Transformation

The final and most revolutionary approach is what I call transformation. Transformation, which has also been called regulatory reform,[331] refers simply to the alteration or repealing of traditional rules.[332] This can occur at the level of an individual rule so that the substance of the rule is changed. However, we may also speak of transformation when the overall nature of the whole legislative framework changes. Usually, the aim is that the rules will apply to both existing and new technology and their use. In this case, it is deemed necessary to not only create rules that would address the sociotechnical change in the existing system but to create a system that would address the changed sociotechnical situation in the best overall way possible. Perhaps even future technology is considered. The point is to avoid the "operational and ideological baggage",[333] as referred to in the beginning of this study. In the case of drones, the safety and security rules would be changed so that both manned and unmanned aircraft could co-exist seamlessly.

Transformation may not be a realistic nor useful goal, as Gregory Mandel has pointed out. The enactment of completely new regimes (that replace existing ones) or making substantial changes to existing laws is expensive, and it is generally difficult to gather political support for such projects. Transformation also takes a lot of time and is a highly uncertain undertaking, since technology may change during the reform and the resulting regime may fall short of its goals vis-à-vis the existing one.[334] From another viewpoint, however, it is precisely sociotechnical change that provides the opportunity to re-examine law. Transformation may provide an impactful legislative solution to the issues, as opposed to relying on alternative rules that can be fragmentary or constrained in their application by the preceding rules.[335]

Another way of understanding transformation, based on Cornelia Vismann's idea of law as a material practice, is offered by Kieran Tranter. He argues that when law faces disruptive technology it does not necessarily have to follow the institutions and practices of modern law at all. Modern law, which is based essentially on written documents and human decision-making—predominantly legislation, court decisions, and registries—might be transformed by (or with) technology itself into

330 Bennett Moses 2011b, pp. 86–87 (cit, *e.g.*, Brenner 2007; Kirby 2008; Wilson 1980).
331 Mandel 2009, p. 79.
332 Hence, I use the concept differently than it is used in, *e.g.*, Stewart 1981.
333 Stokes 2012, p. 94.
334 Mandel 2009, p. 79; 2013, pp. 48–49.
335 See Stokes 2012, p. 95.

something else.[336] This type of transformation is naturally more profound than the mere repealing or alteration of existing rules because it signifies a change in the ontological character of law.

3.4. Contextualizing the Model

3.4.1. Preliminary Distinctions

As any model, the model of legislation and sociotechnical change developed here

> rests on a bet that for certain purposes some phenomena are more important than others. It simplifies down to what it takes to be the essentials. And whether or not it is a satisfactory simplification … is a matter of judgment and … of personal or disciplinary taste.[337]

Hence, the typology of approaches introduced above focuses solely on enacted legislative measures. The approaches are also categorized pursuant to how they relate to existing law. It is not a comprehensive take on how law can and does respond to legal issues created by sociotechnical change. The purpose of this section is to contextualize the five approaches in relation to a number of regulatory distinctions, so as to explicate the perspectives excluded by the typology.

To begin with, the approaches do not address all reactions suggested by the traditional *separation of powers*.[338] In accordance with this idea, response can occur either within the legislative, executive, or judicial branch. It is possible for legislative bodies to create written legal rules (codification) and for administrative bodies to make decisions and apply rules. Courts have the obligation to apply rules and, in some cases, review the actions of the other two branches.[339] Indeed, within the nation states of the world all such branches have been forced to tackle sociotechnical change in diverging ways.[340] In this study, the given distinction applies on the meta level. The study acknowledges that legislation is not the only means by which drones have and will be regulated.

---

336 Tranter 2017, pp. 10–12 (cit., *e.g.*, Vismann 2008). This has similarly been argued by Mireille Hildebrandt (2009). See also Gaudet & Marchant 2011, pp. 176–178; Cloatre & Pickersgill 2015, pp. 6–8 (cit., *e.g.*, Lezaun 2012).

337 Bijker & Law 1992, p. 7.

338 See classically Vile 1998. See modernly, *e.g.*, Carolan 2009.

339 See Bennett Moses 2003, pp. 395 and 401–411 (cit., *e.g.*, Hart & Sacks 1958/1994); 2005, pp. 567–582 (also mentioning the market, which as a regulatory force is excluded from the scope of this study); 2017, pp. 587–588.

340 In the context of drones, for instance, in 2015 the then Finnish Transport Safety Agency (Trafi) issued its first *OPS M1-32: Use of Remotely Piloted Aircraft and Model Aircraft (2015)*. Rules of similar type (but not necessarily of content) had been enacted in several countries across the world. See, *e.g.*, *Arrêté du 11 avril 2012; Regulatory Article 1600: Remotely Piloted Air Systems (RPAS)*.

Another fundamental distinction lies between *international, regional, and domestic* approaches. Generally, direct regulation of technological innovation at the international level is not a realistic option. This is because international law is much weaker in its legislative, executive, and judicial capacity than domestic law. Fundamentally, the sovereignty of states allows them to control new technology however they want. In terms of written law, treaties are cumbersome to draft. Furthermore, the focus of international law is on states rather than private entities, which usually are the key innovators, developers, and disseminators of new technology.[341] The regional and the national are, by default, the dominant levels of legislating sociotechnical change.

Still, the given distinction does not play any part in the typology of legislative approaches. As far as the model developed in this study is concerned, the five legislative approaches can occur on all three levels. Naturally, the present study focuses on civil aviation in which sociotechnical change is largely handled through international and European legislation: the ICAO regime is an important exception to the aforementioned limitations of international law. The study hence compares the international and European responses to unmanned aviation, but this comparison does not affect the categorization of the approaches: they are not founded upon the international or regional character of the examined rules. The study therefore does not explore, for example, whether the case of drones could serve as an example of international law (vis-à-vis domestic law) dealing with new technology through coordination.[342]

The typology is also not based on the differing *specificity* of rules. By this, I refer to the concepts of rules, standards, principles, and recommendations, as introduced in the second Chapter of this study. From a legislative viewpoint, the given concepts signify that sociotechnical change can be approached through more or less predetermined provisions. At one end of the spectrum, there are rules that set forth fixed figures, like the MTOM of a drone; at the other, there are rules that merely include requirements open to interpretation. These differences are ignored in the model, as all five approaches from replication to transformation can include rules of varying specificity. They do not concentrate on the choice between rules, standards, principles, and recommendations.

3.4.2. Technology Governance

There exists a lot of literature[343] that aims to provide the best overall regulatory approach to sociotechnical change. Such literature often proposes a holistic range of

341 Abbott 2011, pp. 127–128; Rayfuse 2017, pp. 506–509.

342 See Abbott 2011, p. 129 *et seq*.

343 The focus here is indeed in literature rather than firsthand documents of governmental policy. This is because literature, for the purposes of this study, offers a more cohesive, comprehensive, and generalized take on technology governance.

measures to anticipate and ultimately deal with new technology, including not only legislation. Indeed, this type of literature eclipses in quantity such that deals with approaches on the level of rules. When written rules are concerned, the focus is on the whole life cycle of the rules rather than how finalized legislation itself appears in relation to existing rules. The literature thus concerns the administrative activity and field of research known as technology governance.[344] Such governance, meanwhile, is part of the broader field of regulatory theory in which a variety of regulatory mechanisms have been explored for the improvement of society.[345]

Participating in the discussion on technology governance by using the responses of ICAO and the EU as a case is beyond the scope of this study. In order to provide arguments in that regard, it would be necessary to conduct an analysis of the operation of the organizations, or at least use material beyond the legal documents referenced here. The aim of the model developed in this study is more modest, as it merely involves categorizing issues and legislative approaches to sociotechnical change. Despite this, it is worthwhile to explore the ways of governing technology more broadly, so as to see which parts of the wider context the model does not address.

First of all, the model makes no attempt at analyzing or categorizing governance approaches that focus on the gathering and dissemination of *information* about sociotechnical change. This includes monitoring the research, development, and market entry of new technology and assessing the potential risks associated with the technology. On a deeper level, it involves increasing the overall expertise and coordination of authorities. The common argument in this regard is that the regulators' early understanding of technology assists in drafting the optimal response.[346] Since the model requires assessing the existence of sociotechnical change using evidence, it could certainly be improved in this aspect in future studies. Incorporating different approaches of gathering technology related information would create a more systemic basis to answer the first preliminary question.

Second, the model does not address the question of *who participates in making the rules*. This includes debates on institutional reforms and alternatives[347] but, more prominently, public, expert, and industry participation or lack thereof. Stakeholder involvement has been promoted at least since the 1970s, when Laurence Tribe authored guidelines for technology assessment in the US Federal Government.

344 See, *e.g.*, Marchant, Allenby & Herkert (eds.) 2011.

345 See generally, *e.g.*, Parker & Braithwaite 2003. See also Drahos (ed.) 2017.

346 *E.g.*, Bennett Moses 2013a, p. 40; Ludlow et al. 2015, pp. 157–161; Mandel 2009, pp. 83–84 and 87–88; Mandel 2013, pp. 52–54 and 57–58. On epistemic governance in regulation generally, see Raman 2015.

347 Abbott 2013, pp. 11–13; Bennett Moses 2017, pp. 587–588 and 590–591 (arguing that the diversity of regulatory institutions should be recognized); Leiser & Murray 2017; Marchant 2011b, p. 204; Marchant & Wallach 2013, pp. 142–152.

According thereto, decision-making on technology ought to involve the broadest possible public participation.[348] Much of the discussion on participation has indeed occurred in the context of technology assessment in which, for example, focus groups, stakeholder workshops, citizen consultation, and expert panels have been used.[349] Another early example of participation is the idea of lawmaking by negotiating its content among stakeholders,[350] which is contrasted by direct final rulemaking in which involvement is initially rejected.[351] More recently, too, there have been calls for identifying and involving stakeholders in order to determine what kind of regulation should be pursued.[352] Sometimes, participation is framed as involving the discovery of shared values[353] or information exchange between private and public lawmakers.[354] Measures such as self-regulation (codes of conduct)[355] and cooperative regulation[356] are also about participation.

The perspective of participation is something that a comprehensive theory of law and sociotechnical change should incorporate. As an element, participation is pervasive: it concerns everything from the recognition of sociotechnical change to the drafting of legislation. Therefore, it is difficult to pinpoint a single stage at which choices regarding stakeholder involvement should be made. One problematic aspect of participation is that the possibilities thereof vary greatly on different levels of regulation (international, regional, and national). This simply makes it harder to systematically implement in a generalized model.

Third, the model does not categorize its approaches on the basis of how they *control and incentivize* sociotechnical change. Discussions of this sort sometimes begin from the observation that law is both a technique of managing technological development—both in a positive and negative sense—and an instrument of enabling technological innovation. Law both prohibits and incentivizes.[357] Thereafter, writers generally argue for a regulatory approach that would best stay on top of

348 Tribe 1973a, pp. 594–597.
349 Bennett Moses 2013a, pp. 40–42 (cit., *e.g.*, Armstrong & Willis 1980; Decker [ed.] 2001; Decker & Ladikas [eds.] 2004; Dunkerley & Glasner 1998; Grin, Graaf & Hoppe 1997; Joss & Durant [eds.] 1995; Sclove 2010). See also Flear & Pfister 2015; Lee 2017; Malloy 2013, pp. 128–135; Sarewitz 2011, pp. 99–104.
350 Dunlop 1976. See in detail Harter 1982. See more recently and more critically Gaudet & Marchant 2011, pp. 169–173.
351 Levin 1995. See also Gaudet & Marchant 2011, pp. 173–176.
352 Abbott 2013, pp. 9–11; Mandel 2009, pp. 82–83 and 90–91; 2013, pp. 60–61; Ludlow et al. 2015, 161.
353 Laurie, Harmon & Arzuaga 2012, pp. 10–25 and 29.
354 Kaal 2014. See also Kaal & Vermeulen 2017.
355 Rappert 2011.
356 Marchant 2011a, p. 28; 2011b, pp. 203–204.
357 Vergès 2014, pp. 76–87 (cit. Cavers 1967, p. 6). See also Malloy 2013, pp. 108–113 (discussing how the US federal government advances technological change). This naturally relates to the discussion above on how law shapes and is shaped by technology.

new technology instead of irrationally hindering or rampantly legitimizing it. For example, the approach should reduce law's negative effects on the development of new products and processes, which would steer such development into a healthier, safer, and more environmentally conscious direction.[358] Recommendations have been made to rely less on doctrinal analysis based on precedents[359] or "command-and-control" type of legislation and more on other tools of governance, such as fees, permits, subsidy programs, public procurement, government research and development,[360] innovation waivers and standard-setting,[361] and informal rather than formal rules.[362] All in all, the call is for more "soft law".[363] Sometimes, culling (prohibiting) the use or sale of the technology altogether is required, sometimes the characteristics of the technology can be transformed to improve its social performance.[364]

This relates to the more general discussion on the *flexibility or adaptiveness* of technology regulation.[365] It has been pointed out that, for instance, the regulator can adopt a "conservative" approach that emphasizes doctrinal analysis in its traditional form, relying particularly on precedents; or, it can resort to a "liberal" approach that pays more attention to the effects of new technology on the interests protected by law.[366] On another note, regulation can be expressed either as standards or screening. The former in this case refers to rules applied uniformly to a category of technology, while the latter to individually tailored assessments.[367] The typology also excludes these considerations.

The aspects of control, flexibility, and so forth are, like the aforementioned aspects, something that a comprehensive theory of law and sociotechnical change could include. However, it is worth pointing out that these distinctions do not address the typology of legislative approaches used here. Alternative rules, for instance, can be just as controlling as traditional ones, or they can be flexible, providing a boost to the developing industry. The aspiration to create an up-to-date and thus socially beneficial legal framework is not rejected but not addressed by the

358 Stewart 1981, pp. 1277–1288.
359 Cockfield 2004.
360 Stewart 1981, pp. 1261 and 1364 *et seq*.
361 Ashford, Ayers & Stone 1985.
362 Kaal 2014. See also Kaal & Vermeulen 2017.
363 Marchant 2011b, pp. 203–204. See also Mandel & Marchant 2013, pp. 31–34.
364 Stewart 1981, pp. 1266–1267.
365 Laurie, Harmon & Arzuaga 2012; Mandel 2009, pp. 78–82 and 88–90; 2013, pp 58–60; Marchant 2011b, pp. 201–203; Paddock & Masterton 2013, pp. 72–75; Saner 2013. Tranter (2005, especially pp. 844 and 855 *et seq.*) has argued that the legislator has a tendency to legislate "for the future", holding a belief in material progress: the new technology is here to stay.
366 Cockfield 2004, especially pp. 383–384, 398–400 and 410–415; Cockfield & Pridmore 2007. Much of the distinction appears to boil down to whether one emphasizes the literal meaning of terms employed in the law or its purpose.
367 Stewart 1981, pp. 1265–1266.

typology either. The typology focuses on responses in relation to existing rules, not in relation to the ability of the rules to stay abreast of, enable, induce, or accelerate sociotechnical change—albeit choosing between, say, replication and alternative rules can incidentally have such effects.

Another aspect not addressed by the model is the *timing* of the response to sociotechnical change.[368] One timing issue is whether compliance should be ensured through *ex-ante* authorization of future behavior or *ex-post* policing of past behavior.[369] The bigger problem is, though, when should the regulator start regulating a developing technology. This is commonly known as the Collingridge dilemma (of control):

> When change is easy, the need for it cannot be foreseen; when the need for change is apparent, change has become expensive, difficult and time consuming.[370]

To elaborate, responding early when the technology is not widely disseminated seems unnecessary and may lead to ineffective or even harmful law, while waiting for the technology to establish itself may make it difficult to control. The uncertainty paradox is that regulators must respond without having much information about the risks and without knowing how the technology will further be developed.[371] It has been asserted that the dilemma applies only to the introduction of regulation that specifically targets new technology, not to cases in which existing laws can be applied.[372] However, I would argue that the dilemma is already present when the choice has to be made between relying on (replicating or emulating) existing rules and drafting alternative rules.

There are several approaches to the dilemma. In general, the call is for agile and ongoing regulation,[373] which links the matter of timing with the matter of flexibility.[374] Measures vary greatly, including the ensuring of safety before allowing the technology to be used (the precautionary principle),[375] the involvement of experts, the enactment of broader obligations, improving the capacity of regulators

368 See, *e.g.*, Abbott 2013, pp. 3–6; Askland 2011, pp. xv–xvi; Bennett Moses 2013b, pp. 8–9; Gaudet & Marchant 2011, pp. 168–169; Kaal & Vermeulen 2017, pp. 188–189 and 194; Kolacz & Quintavalla 2018.

369 Stewart 1981, p. 1269. See also Bennett Moses 2005, pp. 564–565.

370 Collingridge 1980, p. 11.

371 Asselt, Vos & Fox 2010.

372 Bennett Moses 2017, pp. 588–589.

373 Brownsword, Scotford & Yeung 2017, pp. 13–14.

374 See Bennett Moses 2017, p. 590.

375 Stirling 2017. See also Marchant 2011b, pp. 200–201 (noting, however, that precaution should not block potential benefits); Sunstein 2003 (arguing that the principle gives no real guidance); Tribe 1973a, pp. 600–602.

to manage uncertainty,[376] temporary legislation (sunset provisions),[377] threats of regulatory action,[378] or legislation that enables incremental changes.[379] Most of such approaches fall under the scope of adaptive governance.[380]

The approaches to the Collingridge dilemma are yet another element that a comprehensive theory of law and sociotechnical should take into account, as they involve the whole legislative process. In terms of legislative approaches, the typology used in the present model does not address nor exclude ideas like temporary legislation and regulatory threats. The choice between temporary and permanent legislation, or between a regulatory threat and a finalized document, is simply different from the one between, say, replication and emulation. Provisions that emulate existing law can be temporary or permanent. Hence, including these perspectives remains a task for future studies.

Finally, the model is not directly aimed at discerning approaches that are *technology/technologically neutral* and approaches that are not. The ideal of neutrality has in the EU been expressed as follows: rules should not require, promote, or protect the use of a particular technology but instead ensure equivalent regulation of services irrespective of the means their delivery.[381] Sometimes, this idea has been promoted in literature,[382] sometimes criticized.[383] At times, it has been pointed out that since there is no true neutrality it would be more prudent to describe regulation as more and less technologically neutral or specific.[384] The discussion on neutrality is related to what should be the *target* of regulation in sociotechnical change: the technology (product or process) or the people involved (manufacturers or users)?[385]

From a sociotechnical perspective, this question is naturally somewhat nonsensical, as law is seen as targeting both simultaneously. Regardless, the whole question of neutrality or specificity is highly contextual. Of the approaches identified in this study, replication and emulation seem at first to follow the ideal of neutrality. When existing rules are followed, it would appear that new technology is not favored over the old or vice versa. However, from another perspective, creating alternative rules for the new technology actually aids ensuring technology neutrality. This compensatory viewpoint argues that specific legislation may be necessary to, on one hand, enable

376 Bennett Moses 2013b, p. 8.

377 Gersen 2007. See also Cortez 2014; Gaudet & Marchant 2011, pp 178–179; Marchant 2011a, p. 29.

378 Wu 2011. But see Cortez 2014.

379 Kahn 2016, pp. 3–4; Mandel 2009, p. 89.

380 Marchant 2011b, pp. 201–203.

381 *Commission Communication (1999) 539*, pp. vi and 14–15; *Directive 2002/21/EC*, Preamble, para. 18.

382 Kahn 2016, pp. 2–3; Tribe 1973a, pp. 597–599.

383 Greenberg 2016.

384 Bennett Moses 2017, pp. 585–587 (cit., *e.g.*, Reed 2007).

385 See Bennett Moses 2005, p. 564.

the sociotechnical change and, on the other hand, to curb its negative impact.[386] While the typology of approaches used here can therefore aid in understanding the technological neutrality or non-neutrality (specificity) of legislation, its elements do not match the distinction in an obvious manner—indeed, the distinction itself is hardly obvious when put into practice.

386 See Hildebrandt & Tielemans 2013, p. 510. See also Bennett Moses 2017, p. 587.

4. Unmanned Civil Aviation and Existing Law

4.1. Aviation Safety and Security

Pursuant to the model of legislation and sociotechnical change developed in the preceding Chapter, the first matter is to recognize whether a sociotechnical change is taking place in the case at hand. It seems that, in the course of the Introduction, the study has already established that the increase in unmanned civil aviation represents such a change. The element of technology is the civil drones themselves, and the social aspect is their use, development, and alteration in various different contexts and for various purposes. Finally, there is also a distinguishable change to the preceding sociotechnical situation in which the amount and quality of drones was significantly lower. To be sure, there is currently no change occurring in the sense that manned aircraft would be replaced by unmanned ones. Instead, civil aviation as a whole is changing so that unmanned aviation is being added into the shared airspace.

Regardless of what has been established thus far, the present Chapter seeks to examine more closely the ongoing sociotechnical change in civil aviation. To this end, it presents a more detailed set of facts about the overall differences between manned and unmanned aviation. Thereafter, the Chapter examines many existing rules of aviation safety and security that could apply to drones and the possible issues with their application. The following is thus an attempt to apply parts of the model of legislation and sociotechnical change to the present case.

Prior to delving into the argumentative narrative of the study, some attention must be devoted to two fundamental concepts of this study: aviation safety and security. Safety and security are concepts commonly employed in law; regulatory regimes generally focus on safety risks.[387] The concept of safety is most typically used in health law,[388] while security (excluding the term's distinct use in insolvency law) is frequently invoked in the context of international law.[389] However, in air law both terms hold a special meaning somewhat distinct from their meaning in other fields of law.

The safe and orderly development of international civil aviation is one of the objectives of the Chicago Convention, pursuant to the third paragraph of its Preamble. One of the objectives of ICAO, an Organization also established in the Convention, is to ensure the safe development of international civil aviation.[390]

387 Ludlow et al. 2015, p. 151.
388 See, *e.g.*, Schneid 2018.
389 See, *e.g.*, *Charter of the United Nations*, *passim*.
390 *Convention on International Civil Aviation*, Art. 44, para. 1, subpara. a.

Aviation safety, sometimes known as flight safety, is the core principle of European air law, too. After all, the most important advisory body of European Union in aviation matters is the European Aviation *Safety* Agency.[391] The Basic Regulation, which establishes the competence of the Agency in terms of aviation, calls first and foremost for the ensuring of "[a] high and uniform level of civil aviation safety".[392]

Aviation security, though a more recent addition to the terminology of air law, is also important. As stated in the very beginning of the Preamble to the Chicago Convention, the "abuse [of international civil aviation] can become a threat to the general security." Hence, one of the Annexes to the Chicago Convention, including SARPs, is dedicated to security.[393] In the EU, one of the objectives of the latest EASA Basic Regulation is to "contribute … to establishing and maintaining a high uniform level of civil aviation security".[394] Given the Agency's primary focus on safety, the Regulation particularly points to cases in which there are interdependencies between civil aviation safety and security.[395]

What is, though, the distinction between the two, if any? Safety, as defined by ICAO for instance, is a broad concept. This is apparent from both of the definitions adopted by the Organization. In a 2001 Working paper, they defined it as "[t]he state of freedom from unacceptable risk of injury to persons or damage to aircraft and property".[396] In their 2013 Safety Management Manual, they described it as

> 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.[397]

The definition of safety appears to also include security, which in ICAO as well as the EU has commonly been defined as safeguarding civil aviation against acts of unlawful interference.[398] This position has been held by at least Jiefang Huang, who has argued that safety cannot be limited to accident prevention. According to his reasoning, safety is about risk management in a broader sense and has a political, strategic, and legal dimension. He has further maintained that security is an essential aspect of safety rather than an individual field of regulation.[399]

391 Emphasis added.
392 *Regulation (EU) 2018/1139,* Preamble, para. 1.
393 *Annex 17: Security*.
394 *Regulation (EU) 2018/1139*, Art. 1, para. 2, subpara. f.
395 Ibid., Art. 88.
396 *ICAO Working Paper AN-WP/7699: Determination of a Definition of Aviation Safety*, para. 2.2.
397 *ICAO Document 9859: Safety Management Manual*, ch. 2.
398 *Annex 17: Security*, ch. 1; *Regulation (EC) No 300/2008*, Art. 3, para. 2. See in detail Mironenko Enerstvedt 2017, 117–137.
399 Huang 2009, pp. 4–5.

On a conceptual level, my opinion is that the distinction between aviation safety and security is valid in an informative sense. The distinction is common parlance within the aviation industry, hence its use in the title and content of this study. Safety is usually seen as including elements like airworthiness, pilot certification, and operational approval; security appears to include aspects like restricting access at airports, controlling hazardous materials, and preventing crime. The latter includes hijackings, or in other words, the unlawful seizure of civil aircraft; the placing of armed explosives aboard civil aircraft; the use of weaponry like air-to-air or surface-to-air missiles against civil aircraft; and the use of civil aircraft themselves as a weapon or as a tool of other crime.[400]

An exact line between the two is difficult to draw in practice, however. It seems odd to draw it at "unlawful interference", which traditionally has been the distinguishing feature of security-related issues. This is because it is a very broad term. Breaching almost any rule or recommendation issued by ICAO, the EU, or national legislators or authorities could be regarded as unlawful interference with civil aviation. Furthermore, the concept does not address the motives of the party doing so. For instance, if maintenance personnel fail to use approved parts to repair an aircraft, they most certainly unlawfully interfere with civil aviation. Yet this does not seem like a security issue in the way the industry generally perceives security; it is categorized as a safety issue.

It might be more informative to frame the distinction as concerning the intent of the parties causing the harm to civil aviation. From this perspective, safety would be about the prevention of *unintentional* harm, which we generally call accidents; meanwhile, security would be about the prevention of *intentional* harm, which generally falls within the ambit of crime. To an extent, this enables distinguishing what we typically regard as safety issues, such as negligent aircraft maintenance, from security issues, such as the placing of explosives aboard aircraft. If, in the example above, the personnel mistakenly use unapproved parts to repair the aircraft, it is a safety issue; if they do so with the intention of bringing down the aircraft, it is a security issue. This is the approach followed in the fourth article to this study.

Upon a closer examination, though, the distinction is hardly perfect. Not all intentional causing of harm is criminal, while some negligent behavior can be. Additionally, discovering the motivations of the parties involved can be difficult and seems unrelated to aviation safety and security as field(s) of law. Going back to the example on maintenance, it might be impossible to ascertain whether the use of unapproved parts was intentional or unintentional. The management of the airline may have intentionally acquired unapproved parts to cut down costs, but the maintenance personnel possibly did not know that the parts were unapproved. The

400 See, *e.g.*, Elias 2010, pp. 1–50; Klenka 2019; Price & Forrest 2016, pp. 45–100; Schiavo 2008; Sweet 2008, pp. 13–36 and 55–104.

legislative measures to prevent such problems should, regardless, not considerably be affected by the possible motivations of the people involved.

Furthermore, in real life, concerns tend to move between the categories and are regulated in a mixed manner. A negligent placing of flammable liquids in luggage is targeted by aviation security measures and concerned a security threat, even if it were unintentional. If such materials are loaded on board an aircraft, they are considered a safety threat. Targeting civil aircraft with anti-aircraft weaponry is another good example. It is certainly unlawful interference, but it can be either intentional or unintentional, depending on the motivations of the persons using the weaponry. Rules on airport security have no bearing on it, but standards on the identification of aircraft, which are usually regarded as falling within the ambit of safety, do. Such acts therefore seem a matter of both safety and security.

Another plausible way to distinguish safety and security is to label safety as concerning internal threats and security as external threats. According to this distinction, safety is about "the protection of others from one's own activities", while security is about "protecting oneself from external forces".[401] To follow our previous example, aircraft maintenance is about protecting others, and so negligent maintenance is a safety issue; rules that curb the use of weaponry against aircraft are about protecting the aircraft from external forces, so it is a security matter. Another way to put it is to say that safety is about reducing harm that arises from the operation of the aircraft itself, while security is about reducing harm that comes from outside the operation of aircraft.

The obvious problem with this, however, is to define who or what are the "others", "one's own activities", and "external forces". Maintenance is not only about protecting others but also the financial interests of the owners and the health of the pilots, which are both "insiders" in the aviation activity. Furthermore, some airworthiness rules are designed precisely to protect the aircraft from outside forces although such rules are within the ambit of safety. The same issue persists if we try to define security as concerning harm that comes from outside the operation of aircraft. For instance, in the case of air rage or hijacking, the perpetrator is inside the aircraft as a legitimate passenger, but their behavior does not correspond with what is expected of air passengers. Another illustrative example is a case in which an aircraft is purposefully maintained in a wrong manner, causing an accident. In both cases, the threat appears to arise simultaneously from within and outside the operation of aircraft (and from one's own activities and external forces), causing the distinction between internal and external to collapse.

On the basis of this, Huang's suggestion that security falls within the ambit of safety seems rather sound when it comes to tackling threats. Hence, in this study the distinction primarily serves a customary informative function, as a few subsections and the fourth article discuss matters that are commonly seen as being within the scope of security. However, in the reality of applying the rules, safety and security

401 Scott & Trimarchi 2020, p. 5. See also Fiallos 2019, p. 171.

are interconnected and thus not fruitful to keep apart by force. To elaborate: we must acknowledge that many rules of air law seek to prevent both unintentional and intentional—both internal and external—harm without clearly targeting either. Their goal is, per ICAO's definition of safety, simply to reduce the possibility of all harm.

For example, rules concerning the licensing of aircraft pilots reduce the risk of the pilot making an error (which could be regarded as a safety issue) but simultaneously provide them with competence to deal with hijackers and establish a basis for airlines to audit pilot applicants (which could be considered security issues). This is also the approach followed in the fourth article of this study in which many rules traditionally regarded as safety-related are recognized as simultaneously contributing to security. This can be regarded as the spillover security effect of safety rules. In summary: in some cases it makes sense to distinguish between aviation safety issues and security threats, but ultimately the threats do not clearly fall within the ambit of either "safety" or "security" law. In the prevention thereof, the totality of air law and sometimes the totality of law in general must be considered.

4.2. Characteristic Differences

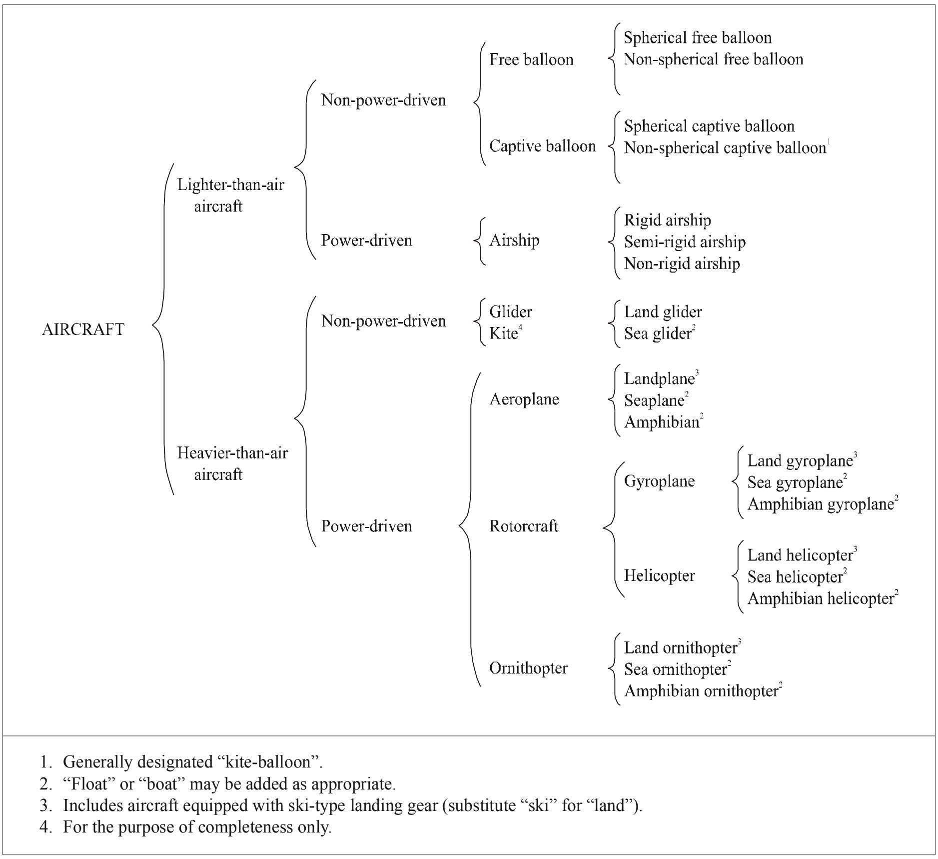
The most central distinction of this study is the one between manned and unmanned aviation. In order to contrast the two, some generalizations of the whole scene must necessarily be made. The references here to manned and unmanned aircraft aim to highlight some differences on average at the expense of encapsulating the heterogeneity[402] of all aircraft. To substantiate the overarching arguments of the study, the differences between extremes (such as gliders versus airliners and camera drones versus human transport drones) are not repeated constantly but acknowledged at certain key points.

Manned aviation here refers to the use of aircraft whose pilot is on board the aircraft. Such aircraft are manned aircraft. The concept of aircraft includes a wide range of machines "that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface."[403] This includes not only aeroplanes ("power-driven heavier-than-air aircraft, deriving ... lift in flight chiefly from aerodynamic reactions on surfaces which remain fixed under given conditions of flight"[404]), which are probably the most iconic type of aircraft, but also helicopters, free balloons, and gliders, to name a few other types. The classification issued by ICAO in the figure[405] below provides a comprehensive picture of the diversity of aviation.

402 See, *e.g.*, Torens, Dauer & Adolf 2018, p. 107.
403 *E.g. Annex 7: Aircraft Nationality and Registration Marks*, ch. 1.
404 Ibid.
405 Ibid.

Meanwhile, unmanned aviation refers to the use of aircraft whose pilot is not on board the aircraft. These aircraft are unmanned aircraft, although since the operation of such aircraft always necessitates other components like the remote pilot station, they are most often called unmanned aircraft *systems* (UAS). The concepts share the definition of aircraft. As argued below and in the first article of this dissertation, drones are by definition *not* “aerial vehicles”, “remotely operated vehicles”, or the like. This means, among other things, that the classification of aircraft presented below applies equally to UAS.[406] For example, there are (or at least can be) unmanned balloons, gliders, airships, gyroplanes, helicopters, airplanes, ornithopters, seaplanes, and the like.[407] The only definitional difference is the location of the pilot(s). UAS is therefore a diverse concept.

[Figure 2: ICAO Classification of Aircraft][408]



406 *ICAO Document 10019: Manual on Remotely Piloted Aircraft Systems*, para. 2.2.1.

407 See Desmond 2018, p. 182 *et seq*.

408 *Annex 7: Aircraft Nationality and Registration Marks*, Table 1. Reproduced with the permission of ICAO.

To begin the discussion on differences from a financial standpoint, manned aircraft are generally expensive to acquire and operate. There are numerous factors connected to this,[409] including the relatively limited and localized need for aircraft, the complexity of the technology, quality (safety) standards for each part and equipment, expensive and demanding pilot certification,[410] as well as the extensive liability of manufacturers[411] and operators.[412] Particularly, high manufacturing and maintenance standards increase the cost but also mean that many models can operate safely for several decades.[413]

At the very low end of the powered airplane spectrum, we have ultralight aircraft like paramotors, which cost several thousand euros. A single engine aircraft sets one back anywhere from €15.000 to €100.000 and a multi engine aircraft anywhere between €75.000 and €300.000. The price of a private jet is at least several million euros, while an airliner sells for hundreds of millions. To this cost, in order to pilot the aircraft oneself, one must naturally add at least several thousand euros in order to train as a pilot. From the perspective of the operator, one must consider operating costs, such as fuel, maintenance, and storage fees at an airfield or airport, and insurance, too.[414] The expenses of starting and operating an airline can amount to billions of euros.[415]

It is important to notice that in some cases unmanned aircraft systems are no different from manned aircraft in their price. Certain drones used for specialized purposes, such as film production, agriculture, surveying, wildlife, surveillance, and inspection, can cost between €15.000 and €50.000, or even over €100.000.[416] The very high-end civil drones are, as a matter of fact, as complex, costly, and large as some general aviation[417] aircraft. This includes drones used for the carriage of

409 It is difficult to establish a clear causal relationship between factors such as the price, complexity, and limited need for manned civil aircraft—they are interconnected.

410 See below.

411 In the EU, *Council Directive 85/374/EEC* establishes a strict liability regime for producers for damages caused by defects in their products (including aviation products). See Mendes de Leon 2017, pp. 363–382.

412 For example, Section 136 of the Finnish *Aviation Act (864/2014)* imposes joint strict liability on the owner, possessor, and user of civil aircraft for damages caused through the use of the aircraft for persons or property not transported on board the aircraft. Similar provisions are set forth in Article 33 of the German *Luftverkehrsgesetz* and Article 76, para. 2 of United Kingdom's *Civil Aviation Act 1982*.

413 See, *e.g.*, *Commercial aircraft fleet by age of aircraft*.

414 See, *e.g.*, Buehler 2018; Houston 2018; Masutti & Tomasello 2018, pp. 16–17. See in detail *Aircraft Cost Evaluator*. In terms of training, for instance in Finland the cost of a private pilot licence is around €15.000, excluding the compulsory administrative fees. See *BF-Lento: Private Pilot Training*.

415 See, *e.g.*, *American Airlines Income Statement*. See generally Doganis 1985/2019; Vasigh, Fleming & Humphreys 2014.

416 See, *e.g.*, *The Vanguard*; *Freefly Alta 8;* Oswald & Lacoma 2019. Note, however, that surveillance and security drones, when used by the police or other authorities, may be regarded as state rather than civil aircraft and thus fall outside the scope of this study.

417 See below for the distinction between different categories of aviation in air operations.

passengers and large amounts of cargo, which are two developing applications that (will) resemble traditional aviation in many aspects. As a prime example, the two-seated EHang 216 passenger drone—an upgraded version of the 184 model—is nearly 6 meters long, carries a payload of up to 260 kilograms, has a top speed of 130 km/h,[418] and reportedly costs some €300.000.[419] Operating such a drone will also necessitate intensive and thus costly training, as the complexity and the risks of the operation are no less than in traditional small scale air transport.

However, in many if not most cases drones are far less expensive than manned aircraft. The drone market is dominated by consumer rather than professional or commercial drones, though the latter are becoming more popular.[420] Since the equipment is non-complex, cheap to purchase, and cheap to store and maintain, there is often little to no financial threshold to operate a drone.[421] A micro-sized model may cost only a few dozen euros. Even equipment falling within the low end of the professional market segment is affordable, ranging from a few hundred euros upwards. Of course, the professional segment is extremely diverse, as it also encompasses drones used for high quality photography, which can cost several thousand euros.[422] In terms of price, these higher-end drones thus come close to the very lowest end of the manned civil aircraft market. The operational and training costs are still much lower, though.

Another characteristic of manned aircraft is that they are usually easy to identify. This is simply due to the size of such aircraft. The length and wingspan of the very smallest manned airplane is two meters,[423] while a typical general aviation plane is larger, being around ten meters in both measurements.[424] Airliners, even the narrow-body ones, are extremely identifiable due to their comparatively massive size.[425] Other types of manned aircraft, including helicopters, autogyros, and balloons, are likewise of notable size.

Identifying manned aircraft is easy also because special equipment has been developed for the exact purpose. The most rudimentary level of identification is provided by the primary service radar (PSR), which detects the distance and heading of any flying object within its reach. The system relies on the size and airspeed of aircraft, which makes them distinguishable from other flying objects, like birds. A more precise form of identification is the secondary service radar (SSR), which

418 *EHang 216 Autonomous Aerial Vehicle*.

419 Weiss & Nicola 2019.

420 *European Drones Outlook Study*, pp. 14–36; *EASA Notice of Proposed Amendment 2017-05 (B)*, pp. 8–12. On the classification, see Miguel Molina & Segarra Oña 2018, Table 2.

421 See Masutti & Tomasello 2018, pp. 16–17.

422 See, *e.g.*, *Best Drones for Sale*.

423 See *Starr Bumble Bee*.

424 See, *e.g.*, *Cessna Skyhawk*.

425 See, *e.g.*, *Airbus A320neo*.

provides information about the altitude and identity of the aircraft, given that the aircraft is equipped with a transponder.

In contrast to manned aircraft, drones are generally difficult to identify. Obviously, the identity of the latter is often obfuscated by their small size. The smallest of drones are only a few centimeters in diameter[426] and thus difficult to even notice, although their sound is usually a giveaway. Yet even some professional models are only some 30 cm long when unfolded.[427] This may make spotting them a challenge, and telling different models let alone individual drones apart is nigh impossible by mere visual cues. The inconspicuousness of drones is exacerbated by the lack of recognition by radar equipment. Unless the drone is equipped with a transponder, which thus far has rarely been the case, the SSR does not communicate with it. Meanwhile, the PSR may not be able to tell a drone from a bird because of similar size and, in some cases, airspeed, which differs from that of manned aircraft. Furthermore, the primary radar is often only an accessory for the air traffic controller because it can get cluttered with a large number of flying objects or fail to detect something. Clutter filters are often applied to counter this.[428]

The automatic dependent surveillance-broadcast (ADS-B), which uses satellites to determine the position of the aircraft, will provide a major relief as manufacturers like DJI have already started installing such technology in most of their drones. Yet the technology in this case simply means that the drone receives signals from manned aircraft and warns the drone pilot (ADS-B in).[429] Mutual identification would require the drone to have ADS-B out capability.

From the perspective of operation, manned aircraft are characterized by their complexity. This is closely associated with their sheer technological complexity, which itself results from the fact that flying for humans is much more technically demanding than moving across land. In comparison with the equivalent commodity in road traffic, the automobile, aircraft are more difficult in almost every aspect: the process of conducting a flight, the knowledge one must have of the surrounding conditions, the reading and use of flight instruments, communication with the air traffic control, and the actions one must take when a particular system fails.[430] Manned aircraft are also more difficult to operate close to each other than cars, hence the constant need for clear separation.[431] Therefore, most manned aircraft are

426 See, *e.g.*, *Best Drones for Sale*.

427 See, *e.g.*, *DJI Mavic 2.*

428 This remains the case although a number of studies have been conducted for the purposes of improving radar drone detection. See, *e.g.*, Coluccia, Parisi & Fascista 2020; Molchanov et al. 2014; Sun et al. 2019.

429 See *DJI Adds Airplane and Helicopter Detectors to New Consumer Drones*.

430 See, *e.g.*, *Air Pilot's Manuals*.

431 On separation rules, see internationally *ICAO Document 4444*, ch. 5. In the EU, see *Commission Implementing Regulation (EU) No 923/2012*, SERA.8005 and 8010; *Regulation (EU) 2018/1139*, Annex V, para. 3, subpara. d and Annex VIII, para. 2.3.4.

virtually impossible to operate successfully without training. This goes for even the simplest kind of aircraft, like paramotors, although such aircraft are far more rudimentary than airplanes or helicopters.

Operating an unmanned aircraft system is very different from operating a manned one. The whole perspective is different, since by definition drones are always flown from outside the aircraft. They can indeed be operated either within the visual line of sight of the pilot (VLOS) or beyond thereof (BVLOS), though sometimes it is possible to utilize a first-person view (FPV). The latter allows the pilot to see a real time video stream from the drone's perspective. Maneuvering is different too, as it is done using a remote controller rather than manual flight controls or fly-by-wire. Drones are also often equipped with features and interfaces that are not similar to the ones used in traditional aircraft. For example, many drones contain an operational mode in which the drone follows its pilot.[432] Despite these differences, UAS are much easier to operate than their manned counterparts. Learning the practicalities of flying a drone commonly requires no special training but a short process of trial and error. This is aided by the fact that drones can fly much more precisely and stay still, which is impossible or difficult for many manned aircraft. The overall approach of trial and error is indeed unthinkable in manned aviation.

Generally, manned aircraft require an aerodrome to operate. By this concept, air law refers to "defined area[s] on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft".[433] At minimum, an aerodrome is simply an air strip but can equally be a full-fledged international airport that handles over a thousand flights per day. The diversity of manned aviation is thus reflected in this regard, too, but the overall point remains. The extreme majority of manned aviation concentrates at aerodromes, which leads to issues like congestion and many aviation institutions focusing their operation at aerodromes.

At the same time, most civil UAS can be flown from almost any location. In order to take off and land, drones only exceptionally require an actual aerodrome with a runway and facilities. Rotary wing models can often safely take off without taking too many precautions with the safety of the surrounding people and property. Fixed wing models, too, are very flexible in the given aspect. This applies especially to the very smallest of models but, to a notable extent, to high-end applications, too. As a matter of fact, this is one of drones' key features and perceived strengths. It means that drones can be used at locations where operating a manned aircraft would not make sense.

As a consequence of their limited and localized need, high cost, and operational difficulties, the number of manned aircraft flying around has been relatively small.

432 See, *e.g.*, *DJI Mavic 2*.

433 *E.g.*, *Annex 14: Aerodromes*, Vol. 1, ch. 1.

At least there have been few aircraft in comparison with other mobile commodities like personal cars. This is the case despite the fact that both are products placed on the consumer market. Although passenger air transport has increased tremendously during the past several decades,[434] general aviation has not become a commonplace activity. For example, in the United Kingdom as of 2019 there were some 20,000 registered aircraft in total,[435] while there were some 31 *million* licensed cars.[436]

Because most UAS are consumer or low grade professional electronics, there is much less emphasis on durability than with manned aircraft. They are not meant to last dozens of years or to undergo scheduled maintenance pursuant to a maintenance program. Many of their parts are not designed to be replaced and therefore cannot be replaced. The typical lifespan of a drone is indeed only around 30 months.[437] Accordingly, drones are being sold in much higher quantity than manned aircraft. As noted already in the introductory Chapter, drones are selling in millions rather than thousands. They are not a luxury good nor a tool of mass scale transportation, at least not yet.

4.3. Issues in Application

4.3.1. Terminology

The exposition above testifies to the fact that there are certain general differences between manned and unmanned aviation and that the amount and quality of the latter is increasing. This shows that civil aviation is undergoing a sociotechnical change. From that fact, we can move onto two matters: whether there are applicable existing rules and what are the possible issues with their application. To consider these questions, the present section begins from a terminological viewpoint and moves onto discuss several substantive themes that provide answers. Reference will be made to the issues categorized in the model developed in the preceding Chapter.

The first article of this study[438] discusses, at length, the issue of finding a proper term to describe aircraft flown without a pilot on board the aircraft and defining the concept appropriately. This problem might, at first, seem of little significance. Yet, given the textual focus of law, the use of improper terms or definitions can easily lead to legal gaps, and resorting to too many terms can generate complexity, incoherence, and confusion. The issue with traditional air law and, to an extent, even the early drone-specific legislative proposals, has been that the terms used therein do not accurately represent the developing industry.

---

434 *Air transport, passengers carried*.

435 *UK Registered Aircraft as at 1st January Each Year*.

436 *UK VEH0202: Licensed cars at the end of the year by keepership*.

437 *EASA Notice of Proposed Amendment 2017-05 (B)*, p. 47.

438 Huttunen 2017.

Consider first the concepts of model aircraft and toy aircraft. Both terms, according to ICAO and EU documents, have been used nationally in reference to aircraft that are intended solely for recreational purposes.[439] Traditionally, "model aircraft" has come to refer to small unmanned aircraft used by hobbyists in associations and clubs. Due to this limited scope, neither concept appropriately classifies the rising drone industry, which includes not only recreational flying but aerial work (specialized operations) and air transport. To call UAS "models" or "toys" is, pursuant to the typology developed here, a case of misclassification. In fact, keeping such terms in use in any form—alongside the proper term adopted for drones—risks creating an artificial distinction that might enable operators to circumvent safety and security rules.[440]

Another concept that wrongly classifies UAS is unmanned aerial vehicle (UAV), which was used in some documents in the early 2000s.[441] One issue with this term is that it implies there are no humans involved in the operation of the aircraft—an issue shared by the term unmanned aircraft (system), which is used here. UAV is worse, though, as it does not recognize drones as aircraft, which they are, but as aerial vehicles. Of course, the very concept of "drone" can be opposed on the same grounds. The latter term also risks including non-aircraft unmanned vehicles, and it is an unprofessional word that has negative connotations.[442]

Legally speaking, perhaps the biggest terminological predicament is with the only provision of the Chicago Convention that (allegedly) seeks to legislate drones: Article 8. First included as an amendment to the 1919 *Convention Relating to the Regulation of Aerial Navigation* (Paris Convention) in 1929,[443] the provision was moved *verbatim* into the 1944 Chicago Convention in which it was supplemented with the second sentence. The provision reads as follows:

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

---

439 *EASA Notice of Proposed Amendment 2014-09,* sec. 2.4.5.4 (cit. *Directive 2009/48/EC)*; *ICAO Document 10019: Manual on Remotely Piloted Aircraft Systems*, para. 1.5.2, subpara. d.

440 *EASA Notice of Proposed Amendment 2017-05 (A)*, p. 9; *"Prototype" Commission Regulation on Unmanned Aircraft Operations*, Explanatory Note, p. 8.

441 *E.g.*, *EASA Advance Notice of Proposed Amendment (NPA) 16-2005: Policy for Unmanned Aerial Vehicle (UAV) Certification*; *ICAO Document 9854: Global Air Traffic Management Operational Concept*, Appendix B, p. 6.

442 Huttunen 2017, pp. 358–360 and 365–366 (cit., *e.g.*, Shoaps & Stanley 2016).

443 *Protocol Relating to Amendments to Articles 3, 5, 7, 15, 34, 37, 41, 42, and Final Clauses of the Aerial Navigation Convention of October 13, 1919*, Art. 15, para. 2.

As I have argued before, both the title and the wording "capable of being flown without a pilot" are problematic. The wording of the provision suggests that it would only include aircraft without any kind of a pilot, leaving out manned aircraft but equally UAS that have a pilot on the ground. Such a reading might create issues in applying the Convention, as drones with a pilot on the ground would fall under the same rules as manned aircraft. For example, they would have the right to non-scheduled flight without special authorization—though this matter should not be exaggerated, as such flights are still subject to the conditions set forth by the overflown state(s). Still, there would be no particular obligation for states to ensure the "controlled" nature of such flights, as the latter sentence of the quoted Article would not apply. The issue could be characterized as misclassification, since the provision appears to wrongly classify drones that have a pilot. Furthermore, given the age of the provision and the very meaning of its words, it might end up becoming irrelevant. If unmanned aviation becomes as sophisticated as manned aviation, there may be no more reason to hold onto the provision. The rule targets a sociotechnical situation in which UAS were dangerous aircraft that were hard to control.[444]

4.3.2. Air Operations

While some rules of aviation safety and security are common to all, others depend on the type of air operation. Internationally, ICAO governs two categories: commercial air transport (CAT)[445] and international general aviation: aerial work, which is the use of aircraft for services like agriculture and photography, is excluded.[446] Of these three, the first is subject to more demanding rules. In the European Union, safety rules employ operational categories such as CAT, non-commercial operations using complex motor-powered aircraft (NCC), non-commercial operations using non-complex aircraft (NCO), and specialized operations (SPO),[447] the last of which means essentially the same as aerial work.

These categories, like the terminology described above, risk misclassifying civil UAS. While the categories may work in classifying some of the high end of drone operations, they fail to address the operational differences at the lower end of the spectrum. As I point out in the third article of this study, the categories are not ideal for drones.[448] For now, for example the distinctions between complex and

444 Huttunen 2017, pp. 354–358. *Contra* Havel & Mulligan 2015 ("the Chicago Convention … anticipated the need for legal regulation of unmanned aircraft"). Cf. Fiallos 2019, pp. 81–86 and 97–98. To be sure, ICAO's *mandate* over international unmanned aviation does not depend on Article 8 at all: nothing in the Convention suggests that the Organization can only manage manned aviation.

445 This refers to "[a]n aircraft operation involving the transport of passengers, cargo or mail for remuneration or hire." *E.g.*, *Annex 6: Operation of Aircraft*, Part I, ch. 1.

446 Ibid., Part II, p. xviii, *in fine*.

447 *Commission Regulation (EU) No 965/2012*.

448 Huttunen 2019c, p. 2.

non-complex aircraft suit the features of drones and their use poorly. Furthermore, in terms of operational risks, it does not always make sense to distinguish between commercial and non-commercial operation or between transport and specialized operation. Naturally, the substantive rules issued for the given categories are largely incompatible with the realities of unmanned aviation.[449] Indeed, although drones with a maximum take-off mass (MTOM) of at least 150 kilograms have been within the ambit of EU air law since 2002,[450] there has never been a clear attempt to bring such aircraft within the scope of the categories. There is thus a cause for lawmakers to come up with a new categorization scheme for civil UAS.

The issues with the substantive provisions on air operations are rather nuanced. According to ICAO SARPs, operators engaging in (international) commercial air transport must acquire an air operator certificate (AOC). This goes for aeroplane and helicopter operators alike.[451] General aviation is exempted from such a requirement but some operational rules still apply.

In the EU, CAT similarly requires an AOC. Being certified is no easy task, since the operator must demonstrate its compliance with all relevant aviation safety and security law, but also finances, insurance, infrastructure, and so forth.[452] Besides AOC, though, the law is more complex than ICAO's rules. Operations using aircraft that fall outside EASA jurisdiction are under national law,[453] and NCO operations need no permission. In three cases, the operator must specially declare its capability to comply with operational rules: when engaging in non-commercial operations using complex motor-powered aircraft (NCC), when engaging in non-commercial specialized operations (SPO) using complex motor-powered aircraft, and when engaging in commercial SPO regardless of the complexity of the aircraft.[454] Obligations imposed on the operation, which continue beyond the issuance of a declaration or an AOC, depend on the operational category but basically cover all relevant safety aspects.[455]

After being approved either through certification or declaration, the air operator is subject to a range of requirements regarding their operational responsibilities. Pursuant to ICAO SARPs, this includes elements like establishing a safety management system (SMS) and ensuring the airworthiness of aircraft, the competency of the aircrew (and its obligations before and during the operation) and

449 Consider, *e.g.*, applying *Commission Regulation (EU) No 965/2012*, Annex VIII to professional drone use.

450 *Regulation (EC) No 1592/2002,* Art. 1, para. 1; Art. 4, para. 2; Annex II, para. 1, subpara. g; *Regulation (EC) No 216/2008*, Art. 1, para. 1; Art. 4, para, 4; Annex II, para. 1, subpara. i. See the following Chapter for details.

451 *Annex 6: Operation of Aircraft*, Part I, para. 4.2.1.1; Part III, para. 2.2.1.1.

452 *Commission Regulation (EU) No 965/2012*, Annex III, ORO.AOC.100 and Annex IV.

453 *Regulation (EU) 2018/1139*, Art. 2, para. 3 and Annex I.

454 *Commission Regulation (EU) No 965/2012*, Annex III, ORO.DEC.100 and Appendix I.

455 See ibid., *passim*.

maintenance staff, and the adequacy of ground facilities—the obligations are too diverse to list here. Many of them also apply to general aviation.[456] In the EU, the operational requirements depend heavily on the operational category but are equally diverse.

In terms of international air transport, the given legal scheme does not seem to cause issues: such UAS activity is likely to be of a scale that necessitates safety standards similar to manned air transport. The domestic carriage of passengers and high volumes of cargo can also be subjected to air operator certification and high operational standards. Otherwise, the problem with certification is that unmanned commercial air transport is a diverse activity, also involving aircraft that present much less of a safety risk to their environment. The delivery of small packages in rural areas is not exactly comparable to airliners flying cargo, although both are technically CAT. In such cases, the AOC risks being an over-inclusive instrument.

In cases other than air transport the same problem persists: the categorizations do not address the whole range of drone operations. ICAO's exclusion of aerial work is particularly limiting in this regard, as such flying currently offers the most use cases for drones. One could view this problem as an issue of under-inclusiveness, although ultimately the issue appears to be the Organization's overall exclusion of any rules on aerial work, which has simply been highlighted by the increase in unmanned aviation.

In the EU, many substantive requirements pertaining to air operation would be over-inclusive if they were directly applied to UAS. For instance, in specialized operations the pilot-in-command has an obligation to ensure that the flight plan includes at least one alternate destination aerodrome. This doubly overstates the necessary safety level for most drones, as it requires both a flight plan and an alternate aerodrome. Naturally, the requirements are partly based on flying by visual or instrument flight rules, which, as the following subsections will examine, have several issues in relation to unmanned aviation. There are also minor provisions that would be over-inclusive for drones, calling for equipment like a first-aid kit, survival equipment, a headset, and radio communication equipment aboard the aircraft.[457] On the other hand, for some UAS operations gaining approval through declaring competency, as the SPO category necessitates, or undergoing certification might be necessary to ensure operational safety.

456 See *Annex 6: Operation of Aircraft*.
457 *Commission Regulation (EU) No 965/2012*, *e.g.*, Annex VIII, SPO.OP.150, SPO.IDE.A.120–126, SPO.IDE.A.165, and SPO.IDE.A.200–215. See similarly *Annex 6: Operation of Aircraft*, *e.g.*, Part II, paras. 2.2.3.5, 2.4.3, 2.4.7, 3.6.2.1, and 3.7.1

4.3.3. Airworthiness

One fundamental example of the high level of safety required in manned aviation is the airworthiness certification of aircraft, which is discussed in most articles of this study. On an elementary level, the Chicago Convention dictates that every aircraft engaged in international aviation must be provided with a certificate of airworthiness.[458] Pursuant to *Annex 8: Airworthiness of Aircraft* to the Chicago Convention and *Document 9760: Airworthiness Manual*, this fundamental requirement boils down to many more specific rules. First, each aircraft type used in international aviation and falling within the scope of the Annex must have type certification (TC). In other words, the design of the aircraft (and parts) is subjected to a thorough process to ascertain its safety and functionality. In addition, each single aircraft must undergo certification to obtain a certificate of airworthiness (CofA). Finally, each aircraft has to undergo regular maintenance to maintain continuing airworthiness. This is ensured by yearly or more frequent inspections whereby aircraft are granted an airworthiness review certificate.[459]

In the European Union, the starting point is that each manned aircraft (along with its engines, propellers, parts, and non-installed equipment) falling within the scope of the EASA Basic Regulation must comply with certain essential airworthiness requirements. These chiefly concern product integrity but also the airworthiness aspects of product operation and organisations that ensure airworthiness.[460] Overall, the EU rules rely on the same instruments as the international ones: TCs, CofAs, and review certificates.[461] There are also distinct airworthiness categories like normal-category aeroplanes[462] and large aeroplanes.[463] High manufacturing standards and qualified maintenance are connected to the fact that aircraft are usually a long-term investment.

The application of EU's essential requirements for airworthiness to drones seems unproblematic: most of the requirements are so general in nature that one might claim all aviation products should comply with them. Beyond the essential requirements, applying the traditional framework of airworthiness appears sensible in cases where the unmanned aircraft system resembles manned aircraft. When the underlying factual premises and risks of the operation are similar, following the kind of safety standards enacted for manned aircraft makes sense. The level of safety requirements for carrying passengers on a two-seater drone could and probably

458 *Convention on International Civil Aviation*, Art. 31. See also Abeyratne 2014, pp. 351–382.

459 *Annex 8: Airworthiness of Aircraft*, Part II. See generally Florio 2016.

460 *Regulation (EU) 2018/1139*, Art. 9, para. 1 and Annex II.

461 *Commission Regulation (EU) No 748/2012; Commission Regulation (EU) No 69/2014; Commission Regulation (EU) No 1321/2014.*

462 *Certification Specifications and Acceptable Means of Compliance for Normal-Category Aeroplanes (CS-23).*

463 *Certification Specifications and Acceptable Means of Compliance for Large Aeroplanes (CS-25).*

should be the same as for carrying them aboard, say, a two-seater airplane or a small helicopter.

With regard to such commercial grade drones, there seems to be no risk of over- or under-inclusiveness, as the purpose of the rules meets the target of application. Neither are the existing rules irrelevant if the relevant aspects of the sociotechnical situation—in this case, the operational risks—remain in place. There is thus an opportunity to skirt some of the common issues and consider replication or emulation as the legislative action.

Still, some of the technological differences between UAS and somewhat comparable manned aircraft may raise various kinds of concerns. Consider, for example, whether and how existing rules concerning the pilot compartment (flight crew compartment) of a manned aircraft should be applied to the remote pilot station of a commercial drone. There is, naturally, a risk of misclassifying the RPS as being the same as the pilot compartment. The RPS is a new entity, unimaginable or at least unimportant to the existing legal framework. Moreover, though, one should question whether applying provisions, such as those on the view from the compartment,[464] would be over-inclusive for an RPS when the operation takes place BVLOS. This does not mean that airworthiness rules on the cockpit have become irrelevant, ineffective, or unjust. It simply goes to show that even when the risks are commensurate, legislative action may still be required to address the divergent aspects of sociotechnical change.

A more unique aspect of unmanned aviation is that it is based on a command and control (C2) link between the drone and the RPS. According to ICAO, the link typically controls the data which modifies the behavior and state of the drone as well as the data that indicates the position and status of the drone. The link also covers detect and avoid (DAA) related functions, data to support the handover of the aircraft from one RPS to another, and data to support flight data recording requirements.[465] In this respect, aviation safety law has been completely lacking applicable rules, since it focuses on aircraft controlled from inside. At the very least, whatever existing standards there may be are ineffective in relation to the C2 link. This is clearly a cause for legislative action regarding all UAS. Similarly, present rules lack certification standards pertaining to automation or autonomy in drones. While manned aircraft use many supportive systems already, autonomy in UAS requires more reliability due to the pilot not being aboard the aircraft as a fallback layer.[466]

Beyond cases in which the drone resembles manned aircraft, applying traditional airworthiness rules is troublesome. Type certification is a prime example, since its

464 *Certification Specifications and Acceptable Means of Compliance for Large (CS-25)*, CS 25.773.

465 *ICAO Document 10019: Manual on Remotely Piloted Aircraft Systems*, para. 11.1.2.

466 Torens, Dauer & Adolf 2018, pp. 108–109.

process is so lengthy and expensive that it is out of the question for most drones. Obtaining a TC would require spending a lot of time and effort for each type of equipment that is often of little value and might only be on the market for a year or two. The same goes for the airworthiness certification of individual drones.[467] The lifespan of most drones is way shorter than that of manned aircraft; a single drone is sometimes only used for a few weeks before being damaged beyond repair. Forcing all UAS to undergo full certification process would also be disproportionate if we consider the risks of the operation. Ensuring the safety of drone operations thus requires a different approach.

Pursuant to the terminology used here, an attempt to apply existing rules on type and airworthiness certification to drones would be over-inclusive. It might seem at first that the same procedures should be followed regardless of the manned or unmanned character of the aircraft, but such a categorial application does not match the purpose of the rules. It seems like a very primitive attempt at technology neutrality.[468] The purpose of the rules is to maintain aviation safety at a particular level, which most drones—though not all, as explicated above—can meet through less demanding rules. Besides over-inclusiveness, there is an argument to be made that traditional airworthiness monitoring would also be ineffective in the context of unmanned aviation. This stems from how drones can and do often operate outside aerodromes and thus avoid oversight.

4.3.4. Aircraft Registration

Another core instrument of air law is the registration of aircraft. Already the Chicago Convention demands each aircraft engaged in international aviation to bear its national and registration marks,[469] which must be shown on the aircraft in a particular manner.[470] This implies an obligation to register every such aircraft,[471] which is also followed with regard to air carriers operating within the EU[472] and, for most other aircraft, in national legislation.[473] Although registration *per se* is not a particularly encumbering obligation, in practice the system is designed for a manageable number of aircraft that are operated for at least several years. For example, the procedure in most states is still done on paper and requires the applicant to provide documents testifying to the ownership, airworthiness, and

---

467 Nothing in the rules suggests that procedures relating to airworthiness should inherently be expensive or time-consuming; however, this naturally results from the extensive obligations embedded in the procedures.

468 See above on technology/technological neutrality in more detail.

469 *Convention on International Civil Aviation*, Art. 20.

470 *Annex 7: Aircraft Nationality and Registration Marks.*

471 Abeyratne 2014, p. 260.

472 *Regulation (EC) No 1008/2008*, Art. 12, para. 1.

473 See, *e.g.*, the Finnish *Act on Transport Services (320/2017),* ch. 12, sec. 8, para. 1; *Aviation Act (864/2014)*, sec. 1, para. 1 and sec. 16, para. 1; *Aviation Regulation AIR M1-2.*

in some cases, insurance of the aircraft. These documents are then verified by the national aviation authority.[474]

Again, there are highly advanced UAS that can be registered through traditional means: these drones are low in quantity, expensive, and professional enough that doing so is justified. Attempting to apply the system to the bulk of drones, though, results in over-inclusiveness. The rules would be excessive, as already recognized in the United States Federal Aviation Administration's 2015 interim final rule.[475] The purpose of the requirements is again tied to the safety level desired for manned aircraft, which in the majority of drone operations can be achieved with less stringency. On a practical level, because of the number of drones, civil aviation authorities would not be able to handle registering them all like manned aircraft. Selling a drone to another person or scrapping it would further require notifying the national aviation authority, which would increase the initial workload. It seems likely, though, that many drone owners would fail to report changes, resulting in misleading registry entries. Even the initial registration is impossible to enforce, unless it is done when the drone is bought. One might further argue that because of sociotechnical change relating to digitalization and mobile devices the whole procedure may ultimate appear ineffective in relation to all aircraft.

The rules on registration and nationality markings, meanwhile, are ineffective when it comes to most UAS. The purpose of these rules is, as with registration in general, identification. It is desirable to visually mark aircraft so that they can be distinguished from one another. In the case of large drones, there is no problem in doing so. However, tiny registration marks on a small drone would not help its identification from a distance at all. It would only aid in identifying drones on the ground. In order to be efficient, the rules would have to come up with a distinct solution to enable the identification of drones.

4.3.5. Personnel Licensing

A large portion of aviation safety law is dedicated to the training and licensing requirements of personnel to operate aircraft—another recurring theme in the articles of this dissertation. The fundamental requirement, according to the Chicago Convention, is that the pilot and other crew members of every aircraft engaged in international aviation must be provided with certificates of competency and licenses.[476] More specifically, pursuant to SARPs adopted by ICAO, only a person trained in a very particular way may be able to work as a pilot, crew member, instructor, air traffic controller, and so forth. The competency of pilots is controlled

474 See *Annex 7: Aircraft Nationality and Registration Marks*.

475 *Registration and Marking Requirements for Small Unmanned Aircraft*, Interim Final Rule, pp. 78617–78618. See also Masutti and Tomasello 2018, p. 74.

476 *Convention on International Civil Aviation*, Art. 32, para. 2. See also Abeyratne 2014, pp. 383–405.

through licences and ratings that concern different operational environments, types of operation, and types of aircraft. Additionally, the pilot must be medically fit to fly.[477] The EU[478] as well as each particular state[479] monitors the competency of pilots similarly to ICAO but in a legally binding and more specific manner.

In the case of drone pilots, the fundamental obligation for every pilot and crew member to acquire documents testifying to their competency seems reasonable. Such an obligation is very general and can be tailored with unmanned aviation in mind. Yet following the standards of manned aviation in whole would be problematic. To begin with, it has not been quite clear if drone pilots should be classified as pilots: they are a new entity that does not quite fit our preconceived notion of an aircraft pilot. This presents a risk of misclassification, as drone pilots might face a collection of unintended requirements.

On a general level, traditional pilot training contains many vital theoretical and practical skills of airmanship that would not be over-inclusive in the context of most unmanned aviation. Such include, for example, the basics of air law, flight planning, and navigation.[480] Leaving drone pilots without such knowledge would perhaps even be under-inclusive. When it comes to the exact level of training, however, attention must be paid to the difficulty and risks of operation. In the commercial segment, high training standards are necessary; with other drones, not so much. Unlike manned aircraft, many consumer grade and even professional UAS can be operated by laymen with no training. Indeed, due to technological developments the operation of drones has become very easy.[481] They are often simple enough that flying lessons are not necessary to begin operation. From this perspective, the existing rules on pilot training appear over-inclusive in relation to drones. Hence, it does not seem sensible to apply to the pilots of such drones traditional licensing and certification procedures, involving dozens (in some cases hundreds) of hours of simulation, instructed flying, and examinations. Upholding such a standard is simply not necessary to maintain the safety of civil aviation.[482]

Yet the case is a bit more complex than that. Some particular elements of traditional training on aviation, such as the mechanics of internal combustion

---

477 See *Annex 1: Personnel Licensing.*

478 *Regulation (EU) 2018/1139*, Arts. 20–28 and Annex IV. See more specifically *Commission Regulation (EU) N:o 1178/2011.*

479 Regarding Finland, see *Aviation Act (864/2014)*, chs. 4 and 6. See more specifically*, e.g., Aviation Regulation PEL M2-70.*

480 See *Regulation (EU) 2018/1139*, Art. 20 and Annex IV. See in detail *Commission Regulation (EU) No 1178/2011.*

481 *E.g.,* Gilbertson 2015. See also *EASA Notice of Proposed Amendment 2017-05 (B)*, pp. 26–27; Masutti & Tomasello 2018, p. 20.

482 See *Commission Regulation (EU) No 1178/2011; Commission Regulation (EU) No 965/2012*; Masutti & Tomasello 2018, pp. 19–20.

engines,[483] would be over-inclusive for many drone pilots. They target aircraft that use such engines, which most drones do not. Meanwhile, drone pilots would require training on issues that have traditionally been unknown, including the whole aspect of flying remotely and the technology involved therein. Drones are also commonly used in urban airspace, which should be taken into account in the training. In this sense, there is also under-inclusiveness and vacuity: no applicable rules.

4.3.6. Airspace

As described above, manned aircraft commonly need an aerodrome for operation. This means that guidance must be provided to aircraft that wish to operate in the vicinity of such congested areas.[484] Hence, air law usually designates the airspace above aerodromes as controlled airspace where aircraft are provided with various air navigation services. One might go as far as to say that present air law is airport centric. Another common segment of controlled airspace are air corridors which generally extend from around flight level (FL) 90–110 (circa 3000 meters) upwards. Uncontrolled airspace, on the other hand, is usually located outside aerodromes at an altitude below such corridors. In such airspace, aircraft are largely left on their own devices apart from receiving certain minimal services. The exact nature of services in all airspace is determined by its class (A–G).[485]

Flights that take place in class A–C airspace are particularly controlled, since aircraft entering such airspace must draft a flight plan[486] and obtain an air traffic control (ATC) clearance. The latter refers to a message by the ATC that authorizes the aircraft to fly in a particular direction, to land, to taxi at the aerodrome, and so forth. These clearances must also be obtained during the flight so as to avoid collision with other aircraft and obstacles. The same function is served by position reports, which the aircraft must issue when passing reporting points, at prescribed intervals, or when requested by the ATC. In controlled airspace, flights are separated from each other both vertically and horizontally in accordance with the requirements set by the airspace class.[487]

Traditionally, air traffic control has relied a lot on voice and data communication[488] between the aircraft and the controller. Pursuant to ICAO standards, aircraft operating internationally must be equipped for radio communication.[489] The same

483 See *Commission Regulation (EU) No 1178/2011*, Annex 1 (Part-FCL), AMC1 FCL.210.

484 On rules concerning aerodromes in general, see *Annex 14: Aerodromes; Commission Regulation (EU) No 139/2014.*

485 See *Annex 11: Air Traffic Services*, ch. 1, sec. 2.6 and Appendix 4; *Commission Implementing Regulation (EU) No 923/2012*, SERA.6001.

486 A flight plan is also required when, for example, operating internationally.

487 *Annex 2: Rules of the Air*, ch. 1, sec. 3.6.1 and 3.6.3 and para. 3.3.1.2; *Annex 11: Air Traffic Services*, paras. 3.3.4–3.3.5; *Commission Implementing Regulation (EU) No 923/2012*, SERA.4001, 6001, 8015, and 8025. See also *Document 4444: Procedures for Air Navigation Services – Air Traffic Management*, sec. 4.4.

488 See *Annex 11: Air Traffic Services*, para. 6.1.1.1.

489 *Annex 6: Operation of Aircraft*, Part I, para. 7.1.1 and Part II, paras. 2.5.1.1–2.5.1.4.

elementary obligation goes for almost all aircraft operating within the EU, whether nationally or internationally and whether commercially or non-commercially, although the exact equipment is dependent on the type and operational environment of the aircraft.[490] In the EU, the aircraft, the pilot, the ground station, and the air traffic controller must also hold a licence to operate their radio. Transmitting signals on aviation frequencies without a permission is not allowed. Naturally, the operator of the radio must undergo radio training as part of their licensing.[491]

In considering the application of the given rules to drones, it is useful to begin from the observation that some commercial unmanned operations will be and perhaps already are designed to operate the same aerodromes and airways as manned aircraft. Most civil UAS, however, have the ability to take off from and land at almost any location. The majority of operations are thus not bound to concentrate around airports. Because of this, the designation of airspace around aerodromes as controlled for ATM and ATC purposes is not very productive when it comes to the whole range of unmanned aviation. Furthermore, since drones commonly operate in very low level airspace they cannot benefit from ATC provided in air corridors. There is rarely air traffic control in low level airspace besides near aerodromes.[492] Obstacles often block traditional radio communication, so there are physical difficulties in extending traditional ATC coverage to low level airspace.[493] Therefore, unmanned operations whose safety would benefit from ATC service may be left without. This shortcoming applies chiefly to urban environments where the safety of natural persons and property can be threatened by drones. From this angle, the existing framework appears under-inclusive, as it excludes air operations it should include.

From the viewpoint of communication requirements, though, one might question whether drone traffic should really be included in the existing framework. There is no pilot on board, so any voice communication will have to take place between the remote pilot station and the ATC ground station. If taken as they are, rules on communication may fail to address the operation of unmanned aircraft. It is worth noting also that radio licences have thus far been issued only to operate a radio on board the aircraft (by the pilot) or a ground station licence to communicate with all aircraft (by personnel on the ground, like the air traffic controller)—not to operate an RPS. These issues apply to drones of all scales.

If these issues were resolved, commercial grade operations could be expected to equip their system with an aviation radio, acquire a licence for it, and train pilots to operate it. The same approach seems over-inclusive for other drone operators,

490 *Commission Regulation (EU) No 965/2012*, CAT.DE.A.330 *et seq*.

491 The licensing requirement stems from *International Telecommunication Union Radio Regulations*, Art. 18. See also *Annex 1: Personnel Licensing.* Regarding Finland, see *Advisory Circular AIR T16-6*, para. 5.1; *Information Society Code (917/2014)*, ch. 6.

492 See *EASA Notice of Proposed Amendment 2017-05 (B)*, pp. 24 and 39–43.

493 Masutti & Tomasello 2018, p. 19.

though. From a safety perspective, there is no need to control all drone traffic through voice communication, as most of it takes place far from manned air traffic and because drone operations can be highly automated. The bigger issue, however, is that it would be over-inclusive in terms of capacity to require ATC personnel to handle communications with all drone pilots by traditional means. As EASA has explicated, the existing ATC/ATM system is human-centric. This is at odds with future expectations, according to which the number of drone operations will be so extreme that manual human control is not possible.[494]

This is to suggest that the traditional framework of ATM and ATC is likely not an appropriate means of controlling mass unmanned aviation. Its territorial scope seems under-inclusive, but this is actually not the main issue. The framework should not even be applied to drones because its measures would be over-inclusive in that context. Another, more salient way to perceive the situation is to regard the traditional rules on ATM and ATC as ineffective: they do not advance safe and orderly air traffic in airspace that is becoming more and more populated by aircraft. As the amount of air traffic grows and as digitalization increases constantly, which is to be expected, this problem will only expand. At some point, sociotechnical change may create a situation in which applying the rules we have for ATM and ATC seems completely ineffective. This necessitates, of course, that novel technology enables creating a more efficient and reliable system for guiding air traffic. Ultimately, the traditional system may even become irrelevant if there are no longer aircraft that require an aerodrome for take-off, landing, and maintenance, or voice guidance.

For the purposes of identification, in international aviation all aircraft must be equipped with an SSR transponder.[495] This requirement applies both to commercial air transport and general aviation.[496] In aviation within the EU, transponder is usually required when the aircraft exceeds a particular threshold for take-off mass, or when the operation takes place in controlled airspace pursuant to instrument flight rules.[497] Passenger aircraft exceeding a certain take-off mass must additionally be equipped with an airborne collision avoidance system (ACAS).[498] Other technical solutions include multilateration (MLAT) in which

494 *EASA Opinion No 01/2020*, p. 28.

495 Transponders operate by using different communication protocols, known as modes, of which three are used in civil aviation: A, C, (usually together as mode A/C) and S. The performance standards of these devices are elaborated on in, *e.g.*, *Annex 10: Aeronautical Telecommunications,* Vol. IV.

496 *Annex 6: Operation of Aircraft*, Part I, sec. 6.20 and Part II, sec. 2.4.13. See also *Annex 11: Air Traffic Services*, para. 2.26.

497 *Commission Regulation (EU) No 1332/2011*, Art. 3 and Annex; *Commission Regulation (EU) No 965/2012*, CAT.IDE.A.350 *et seq*.

498 *Annex 6: Operation of Aircraft*, Part I, sec. 6.19 and Part II, sec. 3.6.9. The purpose of ACAS is to warn the pilots if their aircraft are on a collision course and provide a trajectory that will avoid the collision. See generally, *e.g.*, Tooley & Wyatt 2007/2018, pp. 299–313; *Eurocontrol ACAS Guide: Airborne Collision Avoidance*.

several beacons are used to receive transponder signals, and automatic dependent surveillance-broadcast (ADS-B) in which satellites are used to determine the position of the aircraft.[499]

When it comes to identification, again, the higher end of drones fit the traditional framework of air law better. When an aircraft is large enough, it can be detected by the primary radar, and equipping the aircraft with a transponder is not a financial nor practical obstacle.[500] Identifying most drones with the PSR, though, as explicated in the section on characteristics, is a challenge. Rules mandating PSR could therefore described as ineffective in the era of large-scale unmanned aviation.

For this reason, ATC is nowadays based heavily on the secondary radar. Yet this is also a problematic state of affairs for cheaper drones. To equip these drones with a transponder is a weighty requirement because the price of a transponder in many cases glaringly exceeds the price of the whole system. Virtually all transponders are still designed for manned aircraft in terms of size and connectivity.[501] Some relief could be provided through requiring drones to feature ADS-B in *and* out, but this would increase their cost, too. To extend the obligation to all drones would thus be over-inclusive. Naturally, the aforementioned obstacle problems with radio signals apply equally to the use of the SSR in very low altitudes, which represents another conundrum for transponders.

4.3.7. Flight Rules

Traditionally, every aircraft must follow either of the two types of flight rules: visual flight rules (VFR) or instrument flight rules (IFR), which are both based on the fact that the pilot is on board the aircraft. Flight rules stem from SARPs issued by ICAO; within the EU, they have been adopted as Standardised European Rules of the Air (SERA). Roughly speaking, when operating under VFR, the navigation is based on the eyesight of the pilot(s). Hence, when flying VFR, the pilot must always have certain minimum visibility and keep the aircraft at a certain minimum distance from clouds. When operating under IFR, on the other hand, the navigation is based on the instruments of the aircraft and the guidance by the ATC. This means that the aircraft must be equipped with suitable instruments and navigation equipment and maintain communication with a ground station.[502]

---

499 See, *e.g.*, *European ATM Master Plan: Digitalising Europe's Aviation Infrastructure; Commission Implementing Regulation (EU) No 1207/2011.*

500 Unlike with manned aircraft, however, the transponder must be operable from the ground station.

501 On the characteristics of ATC in detail, see, *e.g.*, Tooley & Wyatt 2007/2018, pp. 278–298. There are several small scale UAS transponder models available but still at a significant cost. See, *e.g.*, *Uavionix Ping200S* (priced at nearly €3.000).

502 *Annex 2: Rules of the Air*, para. 2.2 and chs. 4 and 5; *Commission Implementing Regulation (EU) No 923/2012*, Annex, SERA.2005. There are also subcategories, like special VFR and controlled VFR, discussion on which is not relevant for the purposes of this study. See *ICAO Document 9713: International Civil Aviation Vocabulary*.

On a very basic level, the distinction can be applied to drones. UAS can be flown "under VFR" if the drone is close enough to the remote pilot(s) for the latter to observe the surroundings of the aircraft. Alternatively, if the drone is far away, the system can employ technology like first-person view (FPV) to enable observation. In both cases, it is also possible to fly "under IFR" if the operator relies on instruments rather than visual observation. Still, classifying drone operations solely as VFR or IFR is wrong because the rules begin from the assumption that the pilot is on board the aircraft and always able to observe things from that viewpoint. This is never the case with drones, since a drone is always observed from outside either by the remote pilot or another crewmember either visually or via technology. This has a major impact on the risks of the operation. New terminology is required so that the rules can be targeted appropriately.

The bigger issue with applying VFR and IFR to drones are the rules themselves, which have been designed with the characteristics and risks of manned aviation in mind. One of the more controversial aspects of the rules are minimum flight altitudes. On manned VFR flights, an aircraft must not fly below 150 meters above ground or water; over densely populated areas or open-air assemblies, the minimum altitude is 300 meters. IFR flights must always take place 300 meters above the highest obstacle within 8 kilometers of the aircraft. The latter minimum altitude is 600 meters when flying over high terrain or mountainous areas. Only during the take-off and landing or when permitted by the appropriate authority may the aircraft descend lower. Such a permit may be issued for, for example, emergency operations, aerial photography, leisure flying, or training. Usually, however, air corridors for commercial aviation are located at a very high altitude for reasons of flight safety, noise reduction, and fuel efficiency.[503]

The given provisions do not suit the operation of UAS. While there may be some drones designed to operate from aerodromes and comply with the minima, usually drones fly at an altitude ranging from a few to a few hundred meters. This includes leisure flying and aerial work like photography, forestry, and geomagnetic testing,[504] but most commercial use cases like air transport are similarly based on low level flying.[505] Although manned aircraft frequently operate in low level airspace (besides take-off and landing),[506] this is not the default but rather the exception. The key aspect is that drones present less of a risk to the environment than manned aircraft when flying at a low altitude, so there is no reason to completely forbid them from

503 *Annex 2: Rules of the Air*, para. 2.2 and chs. 4 and 5; *Commission Implementing Regulation (EU) No 923/2012*, Annex, Sec. 5. See also, *e.g.*, Masutti & Tomasello 2018, p. 16; Morris 2017.

504 See, *e.g.*, Salmirinne et al. 2017, p. 29.

505 See White 2018; *EHang Launches Guangzhou as Its First Global Citywide Urban Air Mobility Pilot City; SESAR JU GOF U-space project: Final demo with piloted air taxi flight successfully completed*.

506 Albeit I lack the data to substantiate this, it is a point frequently brought up in discussions within the regulatory work of Eurocontrol, for instance.

doing so. The default minimum flying altitudes are, therefore, over-inclusive in relation to UAS. Applying them consistently would signify the end of the whole drone industry. Furthermore, as unmanned aviation is expected to increase intensely in the following decades,[507] we might face a situation in which the existing fixed limits appear altogether over-inclusive in terms of aviation safety.

While the limitations on altitude are over-inclusive in relation to drones, operating at a very low altitude still invokes many public and private interests that must be protected. For example, even small UAS can pose risks to industrial, business, governmental, and military activities. This highlights the fact that the issue is not only over-inclusiveness but vacuity, too: there are no applicable rules. As a result of relying on the exclusion of air traffic from low level airspace, the existing rules fail to provide any substantive safety requirements about flying an unmanned aircraft at an altitude below the minima. On another note, drones also have potential to be used at extremely high altitudes (of about 20 kilometers above ground). Hence, they colonize the airspace previously less occupied by manned aircraft.[508] In this regard the flight rules are unproblematic since they do not issue any maximum operational altitude.

There are other problems in following VFR and IFR besides minimum flying altitudes. The former rules are, of course, quite difficult for drones to comply with safely because the sensory cues for the pilot are reduced or non-existent. When the drone is observed from outside, the remote pilot may have trouble maintaining the required distances and awareness about the surroundings of the drone. Identifying hazards and taking appropriate action quickly is more difficult, as is identifying and correcting piloting errors. The same applies to cases in which the pilot uses technology to observe the airspace from the drone's perspective. This calls for special standards for detection and avoidance. In the latter situation, there is of course a risk of issues in the connection between the RPS and the aircraft. In order to fly under IFR, the aircraft has to carry navigation equipment and suitable instruments, the requirements of which are based on airworthiness standards and operational categories—both problematic for UAS, as noted above. Naturally, drones are hard to notice in many situations, which is problematic for manned aircraft flying under VFR. Means of *avoiding drones* must also be devised.[509]

507 *EASA Opinion No 01/2020*, pp. 5–6 and 28.

508 Masutti & Tomasello 2018, pp. 14–16 and 19.

509 See *EASA Opinion No 01/2020*, pp. 34 and 42, *in fine*; Fiallos 2019, pp. 176–177; Torens, Dauer & Adolf 2018, p. 106. For the IFR requirements, see *Commission Implementing Regulation (EU) No 923/2012*, Annex, SERA.5015.

4.3.8. Security

As explicated in the final article of this study,[510] security[511] related aviation issues are regulated in multiple ways. To begin with, they are addressed by rules that are outside air law altogether. Many if not all states have enacted legislation for the purposes of monitoring individuals identified as dangerous to national or international security. For example, in Finland the Finnish Security Intelligence Service is in charge of acquiring information for the protection of national security as well as detecting, preventing, and exposing undertakings that may threaten the state or its security.[512]

In the context of air law, security issues are addressed first by rules that are traditionally viewed as falling within the ambit of safety rather than security. This includes rules pertaining to the airworthiness of aircraft, the approval and regulation of air operations, the registration of aircraft, the licensing of pilots, the use of airspace, and flight rules—all of which have been discussed above. For example, the licensing of pilots helps to prevent unauthorized personnel from using aircraft, and airworthiness standards advance security by subjecting aircraft to regular maintenance. This can be called the spillover security effect of safety rules.

In manned aviation, the given safety rules play an important part in deterring security threats. Flying as an unlicensed pilot, for example, is quite difficult because flying an aircraft requires a predetermined location where it can take off and land and because flying is costly and difficult regardless. Facilities for maintenance are also necessary, and identifying the aircraft and the pilot is often unproblematic. This combination of factual necessities and air law makes manned aircraft an easy target for civil aviation and other authorities. In unmanned aviation, one can expect a similar deterring effect in cases where the drone is operated similarly to manned aircraft. Otherwise, however, there is no deterring effect because most UAS are cheap and hard to identify due to their small size and lack of a transponder. They can also be operated without training and covertly from anywhere, and the pilot and the aircraft can be located far away from each other. Their distributed mode of operation increases the risk of them being used for illegal activities and reduces the spillover benefits of safety rules.[513] The issue is probably best characterized as the rules being ineffective in advancing the security of UAS.

Besides the aforementioned rules, air law contains rules that are particularly designated as security related. In Article 3 *bis* of the Chicago Convention, states recognize their obligation to refrain from resorting to the use of weapons against civil aircraft in flight. Meanwhile, *Annex 6: Operation of Aircraft* includes requirements

---

510 Huttunen 2019c.

511 See above for the distinction between safety and security.

512 *Act on Police Administration (110/1992)*, 10 §.

513 Huttunen 2019c, pp. 88–89 and *passim*.

in commercial air transport for the flight crew compartment, aeroplane search procedure checklist, training programmes, and reporting. For instance, the cockpit door of all aircraft that have such a door must be lockable. In aircraft with an MTOM above 45 500 kg, the cockpit door has to resist small arms fire, shrapnel, and intrusion. The aircrew must be trained to understand the behavior of terrorists and to respond with appropriate self-defense measures.[514] Some security-related provisions are included in many other Annexes, too.[515] Similar operational and airworthiness related requirements have been enacted in the EU. There is the obligation to ensure the security of the flight crew compartment,[516] the detailed requirements of which are specified in certification specifications for different classes of aircraft.[517]

These requirements are supplemented by those of *Annex 17: Security*, which focuses particularly on security at airports. Pursuant to the SARPs issued therein, states, airports, and operators are expected to establish civil aviation security programs and to take measures to prevent any dangerous devices or materials from being allowed aboard aircraft. To this end, airside areas at airports must be controlled, security checks must be conducted, and baggage, cargo, and mail must be screened. If there is reliable information of a threat, the appropriate action depending on the threat must be taken. For instance, arrangements must be made to investigate whether there are dangerous devices on board, and the state must assist aircraft that are subject to hijacking.[518] The implementation of Annex 17 is assisted by two documents that are only available for authorized entities and individuals.[519]

In the EU, security-specific rules largely deriving from Annex 17 are particularly included in *Regulation (EC) No 300/2008*, which includes the "common basic standards for safeguarding civil aviation against acts of unlawful interference that jeopardise the security of civil aviation".[520] These rules focus on airports. In accordance with ICAO SARPs, the Regulation demands the creation of security programs by EU Member States, airports, air carriers, and other entities as required by each MS.[521] Besides this, the rules require airports to designate security restricted areas, access to which is controlled. Security is achieved by preventing unauthorized people and vehicles from entering vulnerable locations, like the airside, where for instance only departing passengers, crewmembers, and some airport staff

514 *Annex 6: Operation of Aircraft*, Part I, ch. 13.

515 *E.g.*, *Annex 8: Airworthiness of Aircraft*, Part III, ch. 11; *Annex 9: Facilitation*, chs. 3–5; *Annex 14: Aerodromes*, Vol. I, para. 1.5.1.

516 *Commission Regulation (EU) No 965/2012*, *e.g.,* Annex III, ORO.SEC.100.

517 *Certification Specifications and Acceptable Means of Compliance for Large Aeroplanes (CS-25)*, CS 25.795.

518 *Annex 17: Security*, chs. 3–5.

519 *ICAO Document 8973 – Restricted: Aviation Security Manual; ICAO Document 9985 – Restricted: Air Traffic Management Security Manual.*

520 *Regulation (EC) No 300/2008*, Art. 4.

521 Ibid., Arts. 10 and 12–14.

are allowed. The boundaries are monitored through, *inter alia*, surveillance and patrols.[522]

Another important measure is screening, which is conducted, *inter alia*, using metal detectors, x-ray machines, and hand search. The purpose is to prevent prohibited items, like weapons, explosives, and drugs, from being placed on board aircraft. The screening targets all passengers, their cabin baggage, both passengers' and aircrew's hold baggage, vehicles, mail, and cargo that enter a security restricted area; members of aircrew are subject to a background check before they are issued any identification that authorizes their access. In certain cases, aircraft themselves are subject to searches, and there are procedures to protect them against unauthorized access. For example, persons seeking access are checked, external doors are kept closed, and access can be detected using electronic means.[523]

The existing security-specific rules seem a mixed bag even for drone operations that resemble manned aviation. Conceptually, the rules of course have trouble with classifying the remote pilot station. Substantively, though, the requirement to have a lockable flight crew compartment door seems to make sense also for the RPS. Meanwhile, as of now there are—to my knowledge—no UAS that exceed an MTOM of 45 500 kg, which means that the provisions on the durability of the door are not applicable. From the viewpoint of potential application, they would regardless be over-inclusive for all drones as not even all manned aircraft are subject to such a requirement. Provisions on training the crew to deal with security threats on board could be suitable for high-end drone operations, albeit the provisions would have to be tailored to take into account the special features of UAS. Regarding the security of the RPS, there is ineffectiveness in the sense that the rules do not consider the risk of hijacking from a distance.

Airport-centric security measures naturally apply as they are to unmanned operations that utilize airports. The access to UAS on the airside is restricted and the payload of the drone is subject to screening. The problem is, however, that this excludes the security of the RPS unless the station is located at an aerodrome. Furthermore, only a minority share of total unmanned flights use airports at all. As established above, most drones are operated from outside aerodromes, which puts them outside screening and surveillance of any kind. The vast majority of drones have no capability to even enter controlled airspace, so they are excluded from airports. This suggests that the existing airport-centric security rules are under-

522 Ibid., Annex, sec. 1.1, 1.2, and 1.5. See in detail *Commission Implementing Regulation (EU) 2015/1998*, Annex, sec. 1.1.2–1.1.3, 1.2.2, and 1.5. See also Leloudas 2017; Rossi Dal Pozzo 2015, pp. 71–76.

523 *Regulation (EC) No 300/*2008, Art. 3, para. 15 and Annex, sec. 1.2–1.4 and chs. 3–6. See in detail *Commission Implementing Regulation (EU) 2015/1998*, Annex, sec. 1.4 and chs. 3–6; Commission *Regulation (EC) No 272/2009*, Annex. See also Leloudas 2017, pp. 170–177; Rossi Dal Pozzo 2015, pp. 77–81.

inclusive in the context of drones; at the same time, they risk becoming irrelevant if air transportation exceedingly starts taking place outside airports.

At this stage, security issues should not be over-emphasized because there is only a low amount of high-end drone traffic. As drones are not being used in a widespread manner for human or cargo transport, there is simply little interest to hijack them or use weapons against them. Furthermore, not even all manned aviation is subject to airport security measures since much general aviation takes place at aerodromes without screening and surveillance. Still, there have been several events over the past few years, which show that even consumer-grade drones can pose a threat to their surroundings.[524] A careful consideration of the exact risks and the measures necessary to tackle them is hence required in order to enact appropriate security rules on UAS.

524 See Huttunen 2019c.

5. Legislating Unmanned Civil Aviation

5.1. An Outline of Developments

Thus far, this synthesis has focused on the issues that unmanned civil aviation has caused in relation to existing aviation safety and security law. The present Chapter moves onto discuss the legislative responses the International Civil Aviation Organization (ICAO) and the European Union (EU) have taken in reaction to the issues. The discussion is constructed in accordance with the typology of legislative approaches developed in Chapter 3 as part of the model of legislation and sociotechnical change. Hence, from a theoretical perspective, the purpose is to illustrate the meaning of passivity, replication, emulation, alternative rules, and transformation in the case of civil drones.

Substantively, the Chapter deals with the lawmaking reactions of ICAO and the EU, which are the main legislators of aviation safety and security from a European perspective. Within the EU, the administrative and expert body in charge of substantively developing the rules is the European Aviation and Safety Agency (EASA). In part, with regard to the third article, the study deals with the Specific Operation Risk Assessment (SORA) method, which was originally developed by the Joint Authorities for Rulemaking on Unmanned Systems (JARUS). We are concerned here with the written rules and recommendations issued by these bodies: the steps they have taken to bring drones within the scope of aviation safety and security law. Before delving into the rules themselves, though, it is informative to provide an outline of the developments thus far.

As noted in the Introduction, ICAO's jurisdiction and primary interest lie in creating rules for international unmanned civil aviation. While cross-border operations can be conducted using any UAS, what ICAO has in mind is regular air traffic using the most advanced drone technology. Although the Organization has not yet determined exactly which UAS[525] should fall within the scope of its drone-related SARPs and other documents, it does not appear wanting to regulate consumer grade drones.[526] The Organization can be seen as having begun its work on

525 ICAO uses the term Remotely Piloted Aircraft System (RPAS), but here I simply resort to the consistent terminology applied throughout this study. See Huttunen 2017.

526 See *ICAO Working Paper LC/37-WP/2-5: Clarification of Applicability of the Chicago Convention and SARPs to Certain Categories of RPAS/UAS*. For a criticism of ICAO's approach and an argument on why ICAO should extend its scope to "small" UAS, see Havel & Mulligan 2015, pp. 114–121.

drones in 2003 when the 11th Air Navigation Conference of ICAO endorsed *ICAO Document 9854: Global Air Traffic Management Operational Concept*, which was later adopted by the General Assembly of the Organization.[527] The document was, to my knowledge, the first one to mention civil unmanned aerial vehicles (UAVs), which was an early term for drones.[528]

In 2005, the Organization consulted states and international organizations about drone activities in their airspace, procedures to alleviate risks, and procedures for operational authorization. The first unofficial drone meetings were held in 2006 and 2007. Therein, it was decided that ICAO was not the proper body to develop technical standards and that only some requirements should be included in Annexes to the Chicago Convention (SARPs). On the other hand, it was held that ICAO should have a central role in harmonizing concepts and that it should ensure safety and uniformity in international aviation. Hence, ICAO established the Unmanned Aircraft Systems Study Group (UASSG).[529]

Pursuant to the recommendations issued by the UASSG, several Annexes to the Chicago Convention have been amended to incorporate unmanned aviation. The first one to change was *Annex 13: Aircraft Accident and Incident Investigation* in 2010. A year later, the Study Group published the recommendatory *ICAO Circular 328: Unmanned Aircraft Systems*. As a result of the Circular, both *Annex 2: Rules of the Air* and *Annex 7: Aircraft Nationality and Registration Marks* were amended. In 2014, the UASSG was renamed the Remotely Piloted Aircraft Systems Panel (RPASP), which in 2015 issued *ICAO Document 10019: Manual on Remotely Piloted Aircraft Systems* (RPAS Manual).[530] The Manual outlines ICAO's legislative project, affirming the positions taken in the amended Annexes but also setting forth more extensive guidance on all key issues relating to the safety of international drone operations. In 2018, *Annex 1: Personnel Licensing* was amended to include standards on the licensing of remote pilots. Since then, the Organization has focused its work on other Annexes, like *Annex 6: Operation of Aircraft* and *Annex 8: Airworthiness of Aircraft*.[531]

Within the European Union, drones have been on the agenda since before the turn of the millennium. Throughout the years, chiefly two Directorate-Generals of the European Commission have been responsible for the legislative project:

527 *ICAO Assembly Resolution A35-15: Consolidated statement of continuing ICAO policies and practices related to a global air traffic management (ATM) system and communications, navigation and surveillance/ air traffic management (CNS/ATM) systems*, Appendix B, para. 1.

528 See above and Huttunen 2017, pp. 358–360.

529 *ICAO Document 10019: Manual on Remotely Piloted Aircraft Systems*, paras. 1.2.8–1.2.13.

530 Ibid., paras. 1.2.14–1.2.16.

531 See *ICAO ASBU Documentation,* Thread: RPAS; Masutti & Tomasello 2018, p. 48 (including a table of Annexes to be amended and the estimated year of publication, cit. Spijkert & Lozano 2016).

the Directorate-General for Mobility and Transport (DG MOVE)[532] and the Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW). The Directorate-General for Migration and Home Affairs (DG HOME) has also been involved.

In 1999, Eurocontrol requested the Joint Aviation Authorities (JAA) to consider type certifying UAS and regulating their use.[533] However, when EASA was established in 2002, only drones with a maximum take-off mass (MTOM) of 150 kilograms or over fell within its competency.[534] The special issues with drones were still recognized, as JAA and Eurocontrol established a joint Task-Force whose final report was published in 2004.[535] This and several other projects formed the basis of Working Group 73 that focused on developing precise standards for drone operations.[536] The EASA Basic Regulation was updated in 2008 but the MTOM threshold for drones remained the same.[537] For the airworthiness certification of heavy drones, in 2009 the Agency created *EASA Policy Statement E.Y013-01: Airworthiness Certification of Unmanned Aircraft Systems (UAS)*.

The year 2010 marked the beginning of serious discussions within the EU about a common European legal framework for drones. This included public hearings, high level conferences, and a large consultation under the moniker of UAS Panel Process. A special EU strategy for UAS was drafted.[538] Simultaneously, European Organisation for Civil Aviation Equipment (Eurocae) and Eurocontrol began developing their own concepts about the regulation of drones. The process was hastened by the European Commission, which in 2014 issued *Commission Communication (2014) 207*, calling for the integration of drones into European airspace.

In 2015, the first European High Level Conference on Drones was organized in Riga, leading to the adoption of a declaration.[539] A few months later, EASA issued preliminary information about the precise standards for drones in *EASA Advance Notice of Proposed Amendment 2015-10*. Therein, it suggested abolishing the arbitrary threshold of 150 kilograms and legislating drones in a risk-based manner in three categories: open, specific, and certified. After discussions in the European Parliament, the Commission followed EASA's notice in *Commission Proposal (2015) 613*. The Proposal suggested, among other things, legislating all UAS on the European level.

532 Until 2010, the DG MOVE was preceded by the Directorate-General Transport and Energy (DG TREN), itself only created in the year 2000.

533 Hawkes 2007.

534 *Regulation (EC) No 1592/2002,* Art. 1, para. 1; Art. 4, para. 2; Annex II, para. 1, subpara. g.

535 *UAV Task-Force Final Report: A Concept for European Regulations for Civil Unmanned Aerial Vehicles (UAVs)*.

536 Hawkes 2007.

537 *Regulation (EC) No 216/2008*, Art. 1, para. 1; Art. 4, para, 4; Annex II, para. 1, subpara. i.

538 *Towards the Development of Civil Applications of Unmanned Aircraft Systems (UAS): A Strategy for the European Union (Draft).*

539 *Riga Declaration on Remotely Piloted Aircraft (drones): "Framing the Future of Aviation".*

EASA continued its work, organizing in 2016 another conference[540] and delivering a *"Prototype" Commission Regulation on Unmanned Aircraft Operations*. The third conference ensued in 2017,[541] leading to the publication of *EASA Notice of Proposed Amendment 2017-05* in two parts. These documents followed in the footsteps of the 2015 notice, however containing a more refined view of how drones in the open and specific category should be regulated.

The next step in the European project was to amend the EASA Basic Regulation, which took place in 2018. The new *Regulation (EU) 2018/1139* incorporated all drones within its scope, setting also forth essential requirements concerning the design, production, maintenance, and operation of UAS. Drafts for more specific rules on operation[542] and product regulation[543] were released shortly after, the former being applicable to the open and specific category and the latter being applicable to consumer grade drones. Both drafts passed the vote within EASA and the European Parliament in 2019, leading to their adoption and publication as the *Commission Delegated Regulation (EU) 2019/945* (Delegated Regulation) and *Commission Implementing Regulation (EU) 2019/947* (Implementing Regulation). The applicability of the Regulations proceeds in steps set forth therein. Their implementation is supported by *Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Commission Implementing Regulation (EU) 2019/947* and *Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Part-UAS*, which were issued in late 2019.

The present challenges of the EU with drones include enacting rules on topics such as the airworthiness certification in the certified category, rules of the air for drones, and the U-space concept. In early 2020, EASA issued its *EASA Opinion No 01/2020* on U-space, followed by a *Draft Commission Implementing Regulation on a high-level regulatory framework for the U-space*. As the draft, however, contains some controversial elements from the viewpoint of certain stakeholders, its adoption remains uncertain at the time of writing this.

5.2. Solving the Issues

5.2.1. Old and New Concepts

The first issue identified in Chapter 4 concerns the terms and phrases employed to describe drones. Regarding the problems with the concept of "model aircraft",

540 See *Warsaw Declaration: "Drones as a leverage for jobs and new business opportunities"*.

541 See *Drones Helsinki Declaration*.

542 *Draft Commission Implementing Regulation on the rules and procedures for the operation of unmanned aircraft*.

543 *Draft Commission Delegated Regulation on unmanned aircraft intended for use in the "open" category, and on third-country operators of unmanned aircraft systems*.

ICAO's approach has been passive. The existence of the concept is implicitly approved at the international level, but no legislative action needs to be taken; the RPAS Manual merely notes that many states use such a term, that global standards are not necessary, and that therefore they are outside the scope of the Manual.[544] The European approach, on the other hand, has been alternative rules. While it is recognized that model aircraft are UAS, model aircraft clubs and associations are granted certain exemptions and privileges from the new rules that otherwise apply to drones.[545] This still might lead to some operators abusing the exemptions, but at least the artificial terminological divide between model aircraft and other drones appears to have been eradicated.

To the issues of misclassification and (plausible) irrelevance concerning Article 8 of the Chicago Convention ("pilotless aircraft" and "aircraft capable of being flown without a pilot"), the legislative approach has been passivity. Drones of the 21st century have been deemed as falling within the scope of the provision as it is: no changes to the wording have been deemed imperative. As I note in the first article of this study,[546] there is simply unwillingness to take any unnecessary legislative action to amend the provision, which has remained the same now for nearly a hundred years. Instead, ICAO has resorted to an inclusive reading that guarantees the legal *status quo* by subjecting all international UAS flights to special authorization issued by the state(s) over which the flight takes place. The resort to passivity in this case is practically sound but, from the perspective of treaty interpretation, untenable.

One might claim, however, that ICAO has not gotten away with mere passivity as a response to the issue. This is hinted at by several ICAO documents in which it has been deemed necessary to explicate that modern drones do fall within the ambit of the Article: "'aircraft capable of being flown without a pilot' ... refers to the situation in which there is no pilot on board the aircraft."[547] The 2012 amendments to *Annex 2: Rules of the Air* to the Chicago Convention, which now contains an Appendix containing SARPs for drones, similarly show that affirming the application has been necessary: pursuant thereto, international operation of UAS requires special authorization from the overflown state.[548] The way ICAO has dealt with Article 8 could therefore be viewed as an example of replication, too:[549] the sociotechnical change is handled using existing rules as they are.

544 *ICAO Document 10019: Manual on Remotely Piloted Aircraft Systems*, para. 1.5.2, subpara. d.

545 *Commission Implementing Regulation (EU) 2019/947*, Preamble, para. 27, Art. 16, and *passim*.

546 Huttunen 2017, pp. 356–358.

547 *ICAO Circular 328: Unmanned Aircraft Systems*, paras. 2.1, 2.6, and 4.3–4.5; *ICAO Document 10019: Manual on Remotely Piloted Aircraft Systems*, paras. 1.2.1–1.2.7. See originally ICAO *Document 9854: Global Air Traffic Management Operational Concept*, Appendix B.

548 *Annex 2: Rules of the Air*, Appendix 4, para. 1.2.

549 Cf. Fiallos 2019, pp. 95–97.

In the creation of new drone terminology, both ICAO and the EU have resorted to emulation. Drones are legislated using concepts that are based on the concept of aircraft, which derives from existing rules, but the term is slightly altered to account for unmanned characteristics. ICAO has adopted the concept of remotely piloted aircraft (RPA), which is distinguished from autonomous aircraft (AA). RPA refers to "unmanned aircraft which is piloted from a remote pilot station", and an AA is an "unmanned aircraft that does not allow pilot intervention in the management of the flight";[550] the umbrella term unmanned aircraft (UA) is given no independent significance. When the RPA is supplemented with an RPS and other related architecture, the term is remotely piloted aircraft system (RPAS). The trouble with these concepts, at least in the way ICAO defines them, is that they do not correspond with each other. The opposite of "piloted" is "not piloted" rather than "not allowing intervention", which creates a risk of there being drones (not piloted but allows intervention) that fall in neither category. This makes it difficult to classify drones that operate with some automation or autonomy. Many if not most drones fall somewhere in between the two extremes of remote piloting and autonomous operation.[551]

The EU, as opposed to ICAO, has solely endorsed the umbrella terms UA and unmanned aircraft system (UAS). This avoids the given predicament on a terminological level, as there is no need to distinguish between RPA and AA. Originally, EASA's definition of UA was equally comprehensive: "any aircraft operated or designed to be operated without a pilot on board".[552] However, the 2018 Basic Regulation partly reintroduces the problem of distinction by defining UA in line with ICAO's scheme as "any aircraft operating or designed to operate autonomously or to be piloted remotely without a pilot on board".[553] While this does not exclude UAS that rely on semi-autonomous operation, it does unnecessarily create an impression that autonomous and remotely piloted drones are two clearly distinguishable concepts.

A recognized issue with the term UA/UAS is that it implies that their operation lacks human involvement. The reference to the aircraft being unmanned might lead one to conclude that there is no human involved in the operation at all: not as a crewmember nor a passenger. The issue is, however, rectified by the actual definitions that acknowledge human involvement, causing only the term itself to be somewhat misleading.[554] In this study, this compromise is accepted for several reasons. Since the study focuses on European legislation, following EU terminology is to be

550 *ICAO Document 10019: Manual on Remotely Piloted Aircraft Systems*, pp. xiv and xviii.

551 Huttunen 2017, pp. 361–362.

552 *"Prototype" Commission Regulation on Unmanned Aircraft Operations*, Art. 2, para. 2, subpara. t.

553 *Regulation (EU) 2018/1139*, Art. 3, para. 30.

554 Huttunen 2017, p. 359.

expected. Additionally, using the concept of unmanned aircraft vis-à-vis manned aircraft creates a useful comparative distinction.[555] Finally, as argued previously, UAS is an inclusive concept in that all ranges of automatic or autonomous operation fall within its scope: although different rules may be required, separate terms are not.[556]

Besides using the term UA/UAS, EASA has approved of using the concept of drone in documents that address the general public.[557] In this study, that concept is used alongside UAS to simplify text, to avoid repeating the same abbreviation, and to employ the most popular term used for such aircraft. As argued before, drone is too popular, productive, and useful as a moniker to fade away,[558] even in an academic context.[559] The term itself is perhaps not worth categorizing in terms of approaches since it lacks any official status. It appears alternative to existing air law (though not to common parlance), but since the study defines it similarly to UA(S) its content can be rather seeing as emulating existing rules.

5.2.2. Restructuring Categories

The preceding Chapter noted that, besides terminology, the traditional categorization of air operations and aircraft airworthiness requirements is an issue for unmanned aviation. Categories like commercial air transport, specialized operations, complex and non-complex aircraft, and large aeroplanes appear to fall short when the whole scope of drone activities is concerned.

On the international level, thus far the approach to this issue has been mixed. After a long while of passivity, the amendments to the SARPs did not include any changes to nor made any mention of the existing ICAO distinction between commercial air transport and general aviation. The 2015 RPAS Manual, meanwhile, contains both replication and alternative rules. First, it implicitly recommends continued adherence to the distinction: the recommendations, unless specified otherwise, are to apply to commercial air transport and general aviation, including aerial work. Yet in another paragraph the Manual explicitly states that for drone operations the given distinction is not relevant; instead, the to-be-amended *Annex 6: Operation of Aircraft* will base its distinctions on operational scale and complexity.[560] In other words, the present replication of the categories is to be replaced by alternative rules

555 From this perspective, as an afterthought, contrasting RPA with manned aircraft, as ICAO does, seems slightly off. Would not the opposite of RPA be “close piloted aircraft”, “near piloted aircraft”, or “on-board piloted aircraft” rather than “manned aircraft”? Then again, none of the given terms seem very practical, and they certainly have never been used in any documents.

556 Huttunen 2017, p. 368.

557 *EASA Technical Opinion: Introduction of a regulatory framework for the operation of unmanned aircraft*, p. 5.

558 Shoaps & Stanley 2016, pp. 112–114.

559 See Masutti & Tomasello 2018, title.

560 *ICAO Document 10019: Manual on Remotely Piloted Aircraft Systems*, para. 1.6.3.

in the future. This is also testified to by the Organization's UAS Toolkit for its member states.[561]

From a doctrinal perspective, ICAO's approach is somewhat curious and confusing. Does the Organization ultimately aim to retain the existing categories or replace them with new ones just for drones? Does it wish to include all or just some unmanned aviation within its scope? Deviating from the categorization already devised by EASA[562] would be counterproductive. It seems clear that ICAO wants to legislate unmanned aerial work. Thus far, aerial work has explicitly been excluded from the SARPs on Air Operations, the reasoning being that there is no need of inclusion as aerial work is mainly local or regional.[563] Has or will the increasing amount of unmanned aviation also lead to more *international* aerial work, justifying the creation of new standards? How will these standards differ from the ones used for international unmanned air transport? This remains to be seen.

The European legislators also relied on passivity for a long while. As the framework only concerned drones with an MTOM of 150 kilograms or over, there was no effort to categorize them differently. This changed through the creation of the new legal framework, which establishes an alternative categorization. The EU categories are founded proportionately upon the risk of the operation, the characteristics of the UAS, and the operational environment. It follows an operation centric approach,[564] as opposed to an aircraft centric one. There are three categories—open, specific, and certified—which each contain elements of different legislative approaches: replication, emulation, and alternative rules.

The open category primarily incorporates leisure flying and simple professional scenarios using drones placed on the consumer market. Therein, the operation is not subject to a prior approval of any kind, but it must follow a set of strict limitations that concern particularly the features of the UAS.[565] The certified category, on the other hand, is designed to include the most complicated and dangerous drones and demanding operations, such as passenger transport. More specifically, the category incorporates drones whose design, production, and maintenance is certified. Operationally, the category applies to flying over assemblies of people, human transport, and the carriage of dangerous goods. As such operations are similar to manned aviation in terms of risk, the operator has to comply with rules similar to manned aviation.[566] Between these two extremes the European rules introduce the

561 *ICAO UAS Toolkit*, sec. 2 (Development of UAS Regulation).
562 See below.
563 *Annex 6: Operation of Aircraft*, Part II, p. xix. See also Masutti & Tomasello 2018, pp. 138–139.
564 *Commission Implementing Regulation (EU) 2019/947*, Preamble, para. 5.
565 Ibid., Art. 4 and 7(1), and Annex, Part A; *Commission Delegated Regulation (EU) 2019/945*, Annex I, parts 1–5.
566 *Commission Implementing Regulation (EU) 2019/947*, Arts. 6 and 7, para. 3; *Commission Delegated Regulation (EU) 2019/945*, Art. 40.

specific category, which has been designed with professional applications in mind. As I discuss in more detail in the third article of this study, the specific category authorizes operations on an individual basis. The operator has to conduct a risk assessment, the details of which determine the exact conditions for flying.[567]

The approach to the certification of operators has naturally followed along the given lines. Since it does not seem to be an issue in international commercial air transport, the response of ICAO has been emulation. As a counterpart to the air operator certificate (AOC), the 2012 amendment to *Annex 2: Rules of the Air* requires drone operators to acquire an RPAS operator certificate (ROC) in accordance with national law and consistent with *Annex 6: Operation of Aircraft*.[568] This requirement is affirmed in the RPAS Manual, according to which the ROC is comparable to the AOC. Like the AOC, the ROC allows conducting drone flights in accordance with the specifications included in the certificate. The ROC is not limited to commercial air transport, though, but can equally authorize aerial work, like surveying that takes place internationally.[569] It is thus a separate instrument based on separate rules but draws all its essential characteristics from existing law. Still, the concept also introduces a few wholly alternative standards. For instance, the Manual advices that the drone operator's control and supervision—one of the things the operator must demonstrate for an ROC—should include the use of remote pilot stations.[570]

Beyond the ROC, the RPAS Manual continues with emulation. The drone operator must make sure that the personnel are properly competent, that the continuing airworthiness of the drone is maintained, that the flight crew executes its duties properly, and that the ground facilities are available and enable safe operation. Furthermore, the operator is responsible for ensuring that records of all activities are kept, and that it holds relevant documents at the place of management, the RPS, and aboard the drone itself.[571] The placement of documents aboard the UA appears a silly requirement; however, ICAO has elsewhere noted that the documents can be placed on the device electronically.

The legislative approach taken in the EU is more complex. In the open category, to avoid over-inclusiveness, the approach is passive in that no authorization is required.[572] This passivity is, as described above and below, compensated with product requirements imposed on the drone as well as restrictive flight rules.

The certified category, whose operations come close to manned aviation and ICAO standards, requires the UAS operator to be certified. The details for the certification are thus far unknown, but they will be included in existing regulations.

567 *Commission Implementing Regulation (EU) 2019/947*, Arts. 5, 7, and 11–12.
568 *Annex 2: Rules of the Air*, Appendix 4, para. 2.2.
569 *ICAO Document 10019: Manual on Remotely Piloted Aircraft Systems*, sec. 6.3.
570 Ibid., para. 6.3.4.
571 Ibid., ch. 6.
572 Ibid., Art. 3, para. 1, subpara. a.

The same goes for the substantive obligations imposed on the drone operator.[573] Curiously, this means following the rules of *Commission Regulation (EU) No 965/2012*, which sets forth the categorization of operations into CAT, SPO, etc. Whether this will entail including certified UAS into the existing Parts of the Regulation, which would subject them to the categorization, or creating a new Part altogether, remains to be seen. The legislative course taken by ICAO will likely influence the choice. Suffice it to say that the former option appears problematic, at least assuming that the category will also incorporate operations that are not readily classifiable pursuant to existing Parts. In terms of legislative approaches, to summarize, the basic idea is replication, but the actual rules may come closer to emulation through tailoring the procedure for drones; in some respects, alternative rules may have to be enacted.

The specific category, on the other hand, establishes a completely alternative way of authorizing operators.[574] The operator does not declare its capability nor apply for an AOC; instead, by default, they must acquire an operational authorization (OA). The declaration or certification procedure, which traditionally were employed as individual instruments, are replaced by a holistic process of risk assessment. The risk assessment has been inspired by assessments conducted before, but legally speaking it is more fundamental and broader in its scope and works in a rather unique manner. In fact, the whole specific category largely boils down to the assessment, since it includes not only elements traditionally included in operational declaration or certification but also matters like airworthiness. According to an abbreviated description, the assessment first involves describing the purpose and complexity of the operation, the environment, the features of the UAS, and the competence of the crew. Second, the risks of the operation must be identified, which enables determining the appropriate requirements.[575]

The most prominent method of conducting the assessment is the SORA, which uses a unique system to calculate the mitigations and limitations that must be imposed on the drone operator in order to maintain an acceptable level of aviation safety. To briefly introduce the method, it begins with a concept of operations (CONOPS), which is the operator's description of relevant information. The description reveals, for instance, what is the impact energy of the drone and where it operates. These and other factors form the basis for the ground and air risk class (GRC and ARC), which can be lowered using mitigation measures. The final GRC and ARC determine the required specific assurance and integrity levels (SAIL), ranging from low to high in particular aspects. The SAIL reveals the extent to which (low, medium, or high) the operator must comply with the operational safety objectives (OSOs) set forth in the

573 *Commission Implementing Regulation (EU) 2019/947*, Art. 3, para. 1, subpara. c and Art. 7, para. 3.
574 See Huttunen 2019b, pp. 5–8.
575 *Commission Implementing Regulation (EU) 2019/947*, Arts. 3, 5, 7, 11–12 and Annex, Part B.

SORA Guidelines. The assessment is finalized by considering whether and how the operation may infringe adjacent areas and by writing a safety portfolio.[576]

The alternative character of authorization in the specific category is also visible in the concept of standard scenarios (STS). An STS is a type of drone operation that has undergone the risk assessment process, resulting in predefined conditions that provide an acceptable level of risk mitigation.[577] It is an acceptable means of compliance (AMC), that is, a non-binding standard adopted by EASA to illustrate means to establish compliance with the drone regulations.[578] If the operator wants to operate pursuant to an STS, it need only declare compliance rather than perform the risk assessment anew. The process of declaring compliance appears a case of emulation because it resembles the authorization process adopted for certain operations in manned aviation, like SPO. The concept of STS is, overall, still an alternative instrument, since each scenario is a single operational model rather than a category for a wide range of operations with varying conditions.

Besides having to acquire an OA, the operator in the specific category naturally has some generic responsibilities pertaining to the operation. Among other things, they must establish procedures and limitations with regard to the type of the intended operation and the risk involved; designate a remote pilot for each operation and ensure that all personnel comply with relevant rules on training and other aspects; keep a record of the operations; and maintain the UAS in a condition suitable for safe operation.[579]

The advantages, shortcomings, and criticism of the approach taken in the specific category are appraised comprehensively in the third article of this study. To summarize, however, it is worth noting the following. First of all, the category provides much needed flexibility in the drone framework, but this comes at the cost of the competent authorities having to conduct numerous assessments and do much of the decision-making. The concept of STS might also be abused by operators that do not wish to undergo an actual risk assessment, but if applied properly, it could also foster uniformity. Finally, the SORA method could appear too simplistic or complex, but it does seem capable to correctly assess the risks in the present setting.

Yet another set of alternative rules in the specific category concerns the light UAS operator certificate (LUC). While the concept appears close to the AOCs issued for commercial air transport operators, it is quite unlike such and thus clearly an alternative instrument. The purpose of the LUC is closely connected with operational

576 See *Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Commission Implementing Regulation (EU) 2019/947*, AMC1; *JARUS Guidelines on Specific Operations Risk Assessment (SORA)*; Huttunen 2019b, pp. 6–7; Torens, Dauer & Adolf 2018, pp. 113–116.

577 *Commission Implementing Regulation (EU) 2019/947*, Art. 2, para. 2, subpara. 6.

578 See *Commission Implementing Regulation (EU) No 965/2012*, Annex I, para. 1, subpara. 2.

579 *Commission Implementing Regulation (EU) 2019/947*, Annex, Part B, UAS.SPEC.050.

authorization; namely, it grants the drone operator the privilege to authorize its own operations without submitting a declaration or applying for an authorization from the relevant authority. This unique privilege, which resembles the self-regulation of airlines, comes at the cost of having to comply with standards bordering those developed for the certified category of operations.[580]

5.2.3. Achieving Airworthiness

In the case of airworthiness, it was noted above that much depends on the characteristics of the UAS. As ICAO has focused on high-end international operations, its legislative approach has largely been replication. In other words, the rules draw heavily on standards in place for manned aviation, relying on familiar instruments. While *Annex 8: Airworthiness of Aircraft* is yet to be amended to incorporate unmanned aviation, the RPAS Manual explicitly assumes that procedures applicable to manned aircraft, to the maximum extent practicable, apply to drones. This includes type certification, production approval, continuing airworthiness, and product modifications. Most notably, the obligation for every aircraft in international aviation to be provided with an airworthiness certificate, as included in Article 31 of the Chicago Convention, applies to unmanned aircraft as it is. Furthermore, the Manual notes that *ICAO Document 9760: Airworthiness Manual* should be applied to UAS in most aspects.[581]

It is difficult to criticize the given approach in the context of international air transport. Yet it might be over-inclusive when it comes to some forms of international aerial work, which in the EU likely fall within the specific category. An otherwise low-to-medium risk operation that happens to occur across the border of two states could be subject to more demanding rules than an operation that remains domestic. However, as this matter is largely governed by arrangements between nation states and their civil aviation authorities, no problems should be anticipated. If anything, the respective authorities of states should, in cooperation, determine the rules applicable to such border crossing unmanned aviation that need not be subject to the same rules as manned aviation.

Regardless, the Manual acknowledges that the distributed nature of UAS presents challenges in applying the traditional airworthiness system. In this respect, the recommendations move from replication to emulation. For instance, the aircraft component of the drone must be type certified, while the certification of the other components like the remote pilot station is subject to the aircraft's TC. The RPS may be certified independently, but the holder of the aircraft's TC will be responsible

580 Ibid, Part C and *passim*.

581 *ICAO Document 10019: Manual on Remotely Piloted Aircraft Systems*, para. 4.2.1. See also Fiallos 2019, pp. 164–165.

for the safe integration of the station.[582] The new rules thus make the most of traditional rules on type certification but in a slightly different manner, taking into account the features of the new technology. While the certification arrangement appears confusing, it seems difficult to imagine it handled otherwise in the context of international unmanned aviation.

Meanwhile, the substantive requirements for the RPS interface can be seen as a case of emulating the rules on the flight crew compartment. While the concept of RPS is completely new and employs the command and control link, its basic functions are similar to those of the cockpit of a manned aircraft. Hence, ICAO notes that the requirements for the RPS interface are fundamentally the same as for the interface used in cockpits. The recommendations in the RPAS Manual therefore follow those set forth in Part IIIB of *Annex 8: Airworthiness of Aircraft*, which essentially require the design of the controls to minimize the possibility of inadvertent operations.[583]

The recommendations for the command and control (C2) link, as set forth in the RPAS Manual, are naturally alternative rules. This includes, among other things, rules on the type certification of the C2. In this respect, the Manual recommends that the certification should fall within the certification of the UAS: the link will not be independently certified. Given the lack of existing standards, the Manual also contains initial suggestions on C2 architecture and procedures for recovering the link in situations where it is lost. Some elements of the recommendations contain emulation. Most prominently, the concept of required communication performance (RCP) comes from the document known today as *ICAO Document 9869: Performance-based Communication and Surveillance (PBCS) Manual*. However, the actual RCP values will have to be determined by the manufacturer of the UAS with reference to parameters set forth in SARPs issued by ICAO. Such include communication transaction time, continuity, availability, and integrity.[584]

The EU's legislative approach to airworthiness has, because of the categorization, been much more complex. Essential airworthiness requirements for UAS, as set forth in the EASA Basic Regulation, largely emulate the requirements for manned aircraft. These obligations are very general in nature, so there has not been a need to create alternative rules; reliance on replication and emulation is sufficient. One example of replication therein is that drones must comply with the same environmental performance requirements as manned aircraft.[585] The provision does not seem very significant, since drones are generally less noisy and less polluting than all manned aircraft. However, as noise is a notable issue in urban environments, the example is worth mentioning.

582 *ICAO Document 10019: Manual on Remotely Piloted Aircraft Systems*, sec. 4.4.
583 Ibid., ch. 13.
584 Ibid., sec. 4.5, ch. 11, and *passim*.
585 *Regulation (EU) 2018/1139*, Annex IX, sec. 3.

Examples of emulation are more plentiful, as some modifications to the original requirements have been necessary. For example, the provisions on product integrity read as follows:

> Product integrity, including protection against information security threats, must be assured for all anticipated flight conditions for the operational life of the aircraft.[586]

> Unmanned aircraft must provide product integrity that is proportionate to the risk in all anticipated flight conditions.[587]

The key point in both standards is the same: that the aircraft must withstand all anticipated flight conditions. The provision on manned aircraft, however, emphasizes protection against information security threats and that the integrity must persist throughout the whole life cycle of the aircraft. The latter notion likely stems from the fact that manned aircraft are often used for decades before their decommission. The provision on drones buttresses the proportionality of product integrity in terms of risk, perhaps due to the wide scale of different drones.

Airworthiness certification is required if the drone meets any of the following conditions:

> (a) it has a characteristic dimension of 3 m or more, and is designed to be operated over assemblies of people;
> (b) it is designed for transporting people;
> (c) it is designed for the purpose of transporting dangerous goods and requiring a high level of robustness to mitigate the risks for third parties in case of accident;
> (d) it is used in the 'specific' category of operations defined in Article 5 of *Implementing Regulation (EU) 2019/947* and the operational authorisation issued by the competent authority, following a risk assessment provided for in Article 11 of *Implementing Regulation (EU) 2019/947*, considers that the risk of the operation cannot be adequately mitigated without the certification of the UAS.[588]

In such cases, which fall within the ambit of the certified category—albeit drones with certification can also be used in the specific category—the approach is replication. Since the risks of the certified category are regarded as similar to certain types of manned aviation, the fundamental position is that the traditional rules will be applied as they are: certified drones must comply with the applicable

586 Ibid., Annex II, para. 1.1.1.
587 Ibid., Annex IX, para. 2.1.2.
588 *Commission Delegated Regulation (EU) 2019/945,* Art. 40, para. 1 (emphasis added). See also *Commission Implementing Regulation (EU) 2019/947*, Art. 7, para. 3.

requirements. Airworthiness certification is handled in accordance with existing regulations on type certification and continuous airworthiness.[589] Aircraft in the category must also comply with the airborne collision avoidance system (ACAS) Regulation.[590]

This directly subjects certain drones to the existing airworthiness instruments of aviation safety law. In reality, though, it seems that the rules must be emulated. While the desired level of safety standards may be the same in certified category as in manned aviation, there are still notable technological differences between manned and unmanned aircraft. The airworthiness of a certified category RPS will require new certification specifications (CSs) to be enacted in, *inter alia*, *Commission Regulation (EU) No 748/2012*. In this regard, reference can be made to the 2009 EASA policy statement regarding the airworthiness certification of UAS with an MTOM of over 150 kg.[591] More prominently, though, the necessity of emulation becomes apparent when looking at a JARUS's initial CS-UAS document on type certification. The document concerns MTOM under 8618 kilograms for drones without vertical take-off and landing (VTOL) capability, and 3175 kg for VTOL drones. It excludes passenger transport but includes recommendations on related equipment.[592]

The rules of the open category are technically not airworthiness rules at all: they are rules on product conformity and mandatory features of the aircraft. As such, they are a mixture of replication, emulation, and alternative rules. For example, the obligations of drone manufacturers derive their content from *Decision No 768/2008/EC*, which is a general document on ensuring the quality of products marketed within the EU. The same goes for product conformity assessment modules, like EU-type examination. In some respects, the procedures are exactly the same as with other consumer products; in other respects, they have been tailored for drones. For instance, the modules take into account the class of the UAS (C0–C4).[593]

Some of the rules concern fixed limitations like MTOM, maximum flight speed, and maximum noise level, as well as basic features like lights. For example, the MTOM limits of the drone classes are as follows, including payload:

- C0: 250 grams
- C1: 900 grams

589 *Commission Delegated Regulation (EU) 2019/945,* Art. 40, para. 2 (cit. *Commission Regulation (EU) No 748/2012*; *Commission Regulation (EU) No 1321/2014*; *Commission Regulation (EU) 2015/640).*

590 *Commission Delegated Regulation (EU) 2019/947,* Art. 7, para. 3 (cit. *Commission Regulation (EU) No 1332/2011).*

591 *EASA Policy Statement E.Y013-01.*

592 *JARUS CS-UAS: Recommendations for Certification Specification for Unmanned Aircraft Systems*.

593 *Commission Delegated Regulation (EU) 2019/945*, Art. 6 and Annex.

– C2: 4 kilograms
– C3 & C4: 25 kilograms.[594]

In this regard, the rules emulate the style of existing standards but are otherwise alternative. For example, manned aircraft are also categorized using MTOM limits for the purposes of airworthiness, but the limits used for drones do not coincide with them.[595] The requirement pertaining to safe controllability,[596] being a very generic provision, clearly has its roots in the certification specifications on manned aircraft.[597] Yet there are wholly alternative rules, too. This is best expressed in rules that mandate features that are completely unique to drones. For instance, drones of all classes but C4 must be designed so that they cannot reach an altitude above 120 meters above the surface or above the take-off point. More peculiarly, for example class C1 UAS must have a reliable and predictable method of recovering the data link in cases where it is lost, a capability for direct remote identification, a geo-awareness system, and a system that warns the remote pilot when the battery of the drone is running low.[598]

Requiring drones to have certain features obviously has had an impact on the development of drones and will continue to do so. It is only logical that manufacturers and service providers not only wish to affect the course of legislation but also to organize their business in accordance with what they perceive as being the dominant course. Besides industry affecting legislation, the required features reciprocally affect the development of unmanned aviation technology. If, however, there is a desire to maintain a category of operations open to all without special authorization, the problem cannot be avoided: the requirements will have to be very specific and mandatory.

The approach of the specific category is discussed at length in the third article of the study.[599] Apart from cases in which the drone is certified, the category subjects the airworthiness of UAS to the risk assessment procedure. In other words, the drone must have the technical capabilities set forth in the operational authorization, which is the end result of the assessment; alternatively, the capabilities must match those set forth in the standard scenario.

594 Ibid., Annex, *e.g.*, Part 2, para. 1. The C2 category is not to be confused with the abbreviation for the command and control link (C2).

595 For example, in the EU Light Aircraft include aeroplanes with an MTOM of 1200 kg or less. See *Commission Regulation (EU) No 748/2012,* Art. 1, para. 2, subpara. i.

596 *Commission Delegated Regulation (EU) 2019/945*, Annex, *e.g.*, Part 2, para. 4.

597 See *Certification Specifications and Acceptable Means of Compliance for Normal-Category Aeroplanes (CS-23)*, CS 23.143.

598 *Commission Delegated Regulation (EU) 2019/945*, Annex, *e.g.*, Part 2, paras. 7 and 12–14.

599 Huttunen 2019b.

The SORA method of risk assessment incorporates many elements of traditional certification as operational safety objectives (OSOs). Similarly to type certification, SORA requires drones to be developed in accordance with recognized design standards, and to be manufactured by a competent and/or proven entity. The actual measures to ensure this depend on the necessitated level of safety. At the low end, ensuring material conformity is sufficient, at the medium level the operator must provide evidence about inspections and testing, and at the high level the qualifications of the manufacturers must be ensured through audits and the like. There are additional OSOs regarding the design of all relevant technical aspects of UAS. Continuing airworthiness requirements follow a similar pattern. In low risk scenarios, it is necessary to simply maintain the aircraft pursuant to documented instructions, while at the high level there must be a validated maintenance program and recurrent training for the staff.[600] This approach, while containing familiar elements, is on the whole best characterized as an alternative one.

5.2.4. Registering Aircraft and Operators

When it comes to the registration of drones, the approach of ICAO has largely been to stay passive or replicate existing rules. With regard to Article 20 of the Chicago Convention, which implicitly insists on the registration of all aircraft flying internationally, no action has been deemed necessary. *Annex 2: Rules of the Air* does not especially state that the provision applies to UAS, too, only implying that it does.[601] The RPAS Manual comes closer to replication, as it quotes Article 20, implying that drones fall within its ambit.[602] As ICAO's focus is on the high end of international operations, it does not address the over-inclusiveness issue that concerns the lower end of the spectrum. In terms of registration marks, SARPs emulate existing rules: registration marks on a drone can be "secured in a prominent position near the main entrance or compartment or affixed conspicuously to the exterior of the aircraft if there is no main entrance or compartment."[603]

The EU rules, due to their wide scope, provide a more comprehensive case of dealing with over-inclusiveness. Therein, the idea to register is taken from traditional safety law. However, the drone itself must only be registered when its design is subject to (airworthiness) certification. The ICAO approach of replication is thus followed only in the certified category, or when a certified drone is used in the specific category.

600 *JARUS Guidelines on Specific Operations Risk Assessment (SORA)*, Guidelines, p. 11 and Annex E, pp. 5–11, 15, 20, and 25–26. See similarly *Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Commission Implementing Regulation (EU) 2019/947*, AMC1.

601 *Annex 2: Rules of the Air*, Appendix 4, para. 1.5 and para. 3.2, subpara. c.

602 *ICAO Document 10019: Manual on Remotely Piloted Aircraft Systems*, para. 5.1.1.

603 *Annex 7: Aircraft Nationality and Registration Marks*, para. 9.2, subpara. b. Air transport drones have a main entrance or a (passenger or cargo) compartment, which suggests the provision is targeted at non-transport drones.

In these cases, the nationality and registration marks must naturally be presented on the drone per ICAO's standards.[604]

In other cases, identification is sought by expecting the *operator* to register itself when operating a drone that passes one of the thresholds mentioned in the Basic Regulation and/or Implementing Regulation. For the sake of uniformity, the obligation to register also concerns operators of certified UAS and operations in the specific category.[605] The way this avoids the issues identified previously is that a single operator may use numerous UAS through a single registration. Furthermore, the authorities need not be notified of transactions involving each drone. Much of the bureaucratic burden of the original system is hence reduced. This is emphasized by the obligation to establish a distinct, digital, and interoperable method of registration.[606] The approach contains elements of emulation and alternative rules: although the concept of registration is employed, its target is different and its procedure contains unique elements, too.

The preceding Chapter argued that since registration marks on small drones are useful only at a close distance, the identification of such aircraft would have to be supplemented with other means. To this end, the European rules require the operator to display its registration number on its drones[607] and drone manufacturers to ensure that the aircraft bears a type and a unique serial number that allow for its identification.[608] Alone this emulation of existing rules appears ineffective, but not so when read in its proper context. According to new, alternative rules, in the open category drones with an MTOM of over 250 grams must be equipped with a capability for direct remote identification.[609] This means that the UA will electronically broadcast its registration information, enabling identification as long as the remote pilot inserts their information and does not tamper with the aircraft.

Such capability is not explicitly required in the specific and certified category: it appears only a mandatory feature in the open one. The likely explanation for this is that the specific category seeks to incorporate such a wide range of operations that requiring a remote identification feature in all of them might be over-inclusive; the certified category, meanwhile, is set to rely on traditional registration and operational rules, which may defeat the purpose of having remote identification. Still, it is somewhat odd that the SORA method does not even consider imposing

---

604 *Regulation (EU) 2018/1139*, Annex IX, sec. 4; *Commission Implementing Regulation (EU) 2019/947*, Art. 14, para. 7.

605 *Regulation (EU) 2018/1139*, Annex IX, sec. 4; *Commission Implementing Regulation (EU) 2019/947*, Art. 14, para. 5.

606 *Commission Implementing Regulation (EU) 2019/947*, Preamble, para. 17 and Art. 14, paras. 4 and 6.

607 Ibid., Art. 14, para. 8.

608 *Commission Delegated Regulation (EU) 2019/945*, Art. 6, para. 5; *Decision No 768/2008/EC*, Art. R2, para. 5.

609 *Commission Delegated Regulation (EU) 2019/945*, Annex, Parts 2–4 and 6.

remote identification as a means of reducing the risks of the operation—apart from the seemingly random case that the operator uses a UAS owned by a third party.[610] Regardless, EASA's preparatory work on U-space indicates that the features are mandatory when specific category operations utilize the U-space,[611] which is discussed below.

5.2.5. Rules on Remote Pilots

ICAO's approach to the licensing of UAS pilots—remote pilots—has been replication and emulation. *Annex 2: Rules of the Air* calls for their licensing in accordance with national rules and *Annex 1: Personnel Licensing*.[612] This idea is expanded upon in the RPAS Manual, which employs concepts like the remote pilot licence and establishes the basic requirements for attaining such a qualification. The requirements are overwhelmingly derived from existing rules: Article 32 of the Chicago Convention, which calls for aircraft pilots in international aviation to be certified and licensed, remains unchanged and is applied to remote pilots. However, the terminology of the new recommendations consistently refers to drones and some of their special features.[613] Making few deviations appears to make sense, given the Organization's desire to legislate only international drone piloting.

The Manual's approach is affirmed in the most recent edition of *Annex 1: Personnel Licensing*. Its provisions are applicable from 3 November 2022 onwards to international drone operations that follow instrument flight rules.[614] In order to act as a PIC or co-pilot of an unmanned aircraft, a person must hold a remote pilot licence. The right to pilot a particular type of UAS, like a rotorcraft drone, is endorsed as a category rating on the licence, and class and type ratings are required in particular cases, too. In these aspects and in the substantive training requirements, the licensing draws heavily upon existing rules. The pilot must demonstrate knowledge on, for instance, traditional aeronautical charts, instruments, and navigation aids. Alternative rules are only established for aspects that are unique to drones, like the C2 link and to an extent the RPS.[615]

As explicated above, the most generic provisions on pilot competency would not be over-inclusive in the context of most unmanned aviation. For this purpose, EU's essential requirements regarding remote pilots rely on emulation. Consider, for instance, the following provisions:

610 *Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Commission Implementing Regulation (EU) 2019/947*, AMC1 Article 14(8), para. d, subpara. 3.

611 *EASA Opinion No 01/2020*, p. 13 (the certified category remains unmentioned in this regard).

612 *Annex 2: Rules of the Air*, Appendix 4, para. 2.3.

613 *ICAO Document 10019: Manual on Remotely Piloted Aircraft Systems*, ch. 8. See also Fiallos 2019, pp. 165–167.

614 See below on the application of IFR to drones.

615 *Annex 1: Personnel Licensing*, ch. 2, Part B.

> A person undertaking training to fly an aircraft must be sufficiently mature educationally, physically and mentally to acquire, retain and demonstrate the relevant theoretical knowledge and practical skill.[616]

> Any person involved in the operation of an unmanned aircraft, including the remote pilot, shall possess the required knowledge and skills necessary to ensure the safety of the operation and proportionate to the risk associated with the type of operation.[617]

The core of the rules is the same: a person must have both theoretical knowledge and practical skills to operate an aircraft. The former standard, which applies to the pilots of manned aircraft, though, refers to educational, physical, and mental maturity as well as the demonstration of knowledge and skills. Drone pilots simply have to possess the latter two, and the provision highlights the necessity of the knowledge and skills in proportion to the safety and risks of the operation. This is to remind that many drone operations are of extremely low risk, and that not all operations require the pilot to undergo training.[618]

Following existing standards also works in the certified category, considering that the focus is on commercial unmanned aviation like human and cargo transport. While the category does not yet set out a licensing framework of remote pilots nor refer to *Commission Regulation (EU) No 1178/2011*, the licensing requirement is mentioned in several provisions of the Implementing Regulation. Where applicable, the remote pilot should be licensed.[619] The choice of approach is therefore emulation, much in accordance with ICAO standards.

In lower risk applications, the discussion above highlighted the issue of subjecting the remote pilot to traditional licensing and the topics covered by traditional training. The open category attempts to solve the issue with an alternative approach. In order to pilot a class C1 drone in subcategory A1, for instance, the pilot must complete an online training course and pass a theoretical examination in the Member State where the drone operator is registered. This covers topics somewhat similar to but also different from traditional pilot licensing, including for instance airspace restrictions, UAS general knowledge, privacy and data protection, and security.[620] There is hence emulation of existing requirements, but also alternative requirements.

Online training seeks a balance between the necessity of training and the over-inclusiveness of traditional training. Furthermore, it enables tailoring the substance

---

616 *Regulation (EU) 2018/1139*, Annex IV, para. 1.1.

617 Ibid., Annex IX, para. 2.3.

618 The provision on remote pilots excludes medical fitness and even the provision on regular pilots only hints at it, as the matter is regulated separately.

619 *Commission Implementing Regulation (EU) 2019/947*, Art. 3, para. 1, subpara. c, Art. 6, para. 2, and Art. 18, para. 1, subpara. b.

620 Ibid., Art. 8, para. 1 and Annex, Part A, UAS.OPEN.020.

of training to better suit the characteristics of consumer grade unmanned aviation, solving the issues of under-inclusiveness and ineffectiveness. Online courses are flexible in that their content can easily be tailored on the basis of feedback, of any issues that may arise, and of the development of unmanned technology. On the other hand, online training lacks the oversight present in traditional training in which the prospective pilots must attend teaching and practice sessions. Certainly, there are bound to be rogue pilots who simply want to get over with the course and the exam, ignoring the learning aspect to the extent they can. Another issue is that gaining knowledge or skills that are not part of the course in an accessible form will take additional effort from the pilot, as there is no expert from whom to ask questions.

The specific category also solves training related issues by resorting to alternative rules. In accordance with other safety aspects, the required competency of the remote pilot is set forth in the operational authorization or the standard scenario. In other words, the risk assessment determines the necessary qualifications. This must include at least, *inter alia*, the ability to manage aeronautical communication, manage the flight path and automation of the drone, and maintain situational awareness.[621] Given the wide range of different operations in the category, the training requirements for pilots can be tailored in an even more detailed manner—albeit the SORA method itself does not establish a legal framework for pilot training or licensing.[622] In order to tackle this shortcoming, JARUS has published a separate recommendatory document on the competency of pilots in the open and specific category.[623]

5.2.6. Airspace and U-space

The preceding Chapter acknowledged many drone-related issues with the existing framework of air traffic control and management. These issues are less pronounced in international operations, which is why ICAO's approach in many aspects has so far been replication. According to *Annex 2: Rules of the Air*, UAS simply follow the rules for the airspace where the drone operates. No special rules are issued for performance and equipment requirements, including matters like communication, identification, and separation. A flight plan must be submitted in accordance with the general rules of the Annex or in accordance with the rules issued by the overflown state.[624]

The way the RPAS Manual addresses the concerns recognized above is similar. It does not deal with the lack of ATC/ATM for drones operating outside aerodromes nor with the over-inclusiveness or ineffectiveness of the measures. The possible

621 Ibid., Art. 8, para. 2 and Annex, Part B.

622 *JARUS Guidelines on Specific Operations Risk Assessment (SORA)*, Annex C, p. 4.

623 *JARUS Recommendation for Remote Pilot Competency (RPS) for UAS Operations in Category A (Open) and Category B (Specific)*.

624 *Annex 2: Rules of the Air*, Appendix 4, paras. 1.6–1.7.

inability of the existing infrastructure to handle mass unmanned aviation is not tackled. The focus is simply on how drones can achieve compliance with the infrastructure in cases where it is necessary.

To this end, the Manual explicates that the requirements for ATC communications and ATM procedures are the same as for manned aviation in the same airspace. In both controlled and uncontrolled airspace, drones must not impact the *status quo*. The system must, *inter alia*, meet the required communication performance (RCP) set forth in *ICAO Document 9869: Performance-based Communication and Surveillance (PBCS) Manual* and have the required equipment. The drone itself must be able to move like manned aircraft, complying with markings and signals at the aerodrome. This requires technological and procedural advances, for it is recognized that that some characteristics of drones affect their ability to follow existing rules. To solve the issue of the pilot not being on board the aircraft, the Manual suggests alternative forms of communications architecture.[625] The development of alternative rules thus merely serves the overarching goal of replication.

In terms of identification, the RPAS Manual continues with passivity and replication. As ICAO currently focuses on international operations that utilize IFR capable high-end drones, there is of course no need to address the problems with the primary radar. Existing transponder rules, which fall within the ambit of airspace equipment requirements, are equally unproblematic from the given perspective. They are something to which UAS, too, will have to subject. Remarkably, the Manual does recognize that deviations may be possible in, for example, low level airspace.[626]

For now, and particularly in the context of 2015 when the document was published, ICAO's approach makes sense since it does not risk going too far with its predictions. However, in the grander scheme of things the approach appears to lack vision in how to actually orchestrate future manned and unmanned air traffic. While the Organization's mandate is, in principle, limited to international aviation, it still serves as a forum for legislating both international and domestic aviation. It might eventually have to undertake the task of standardizing future ATC/ATM solutions that incorporate both manned and unmanned aviation in a sophisticated manner. That is, replication may ultimately turn out to be an insufficient solution. This is also the case if ICAO wants to enact rules for drones that are not and ought not to be compatible with the existing ATC/ATM infrastructure. In other words, if the Organization wants to include lower risk operations within its scope, it cannot simply follow the traditional way of doing things.

The European rules go a lot further than ICAO's, since they aim to address drone operations in all airspace. Curiously, the starting point of the rules is replication in the certified and specific category, at least to an extent. The Implementing

625 *ICAO Document 10019: Manual on Remotely Piloted Aircraft Systems*, chs. 12, 14, and 15.
626 Ibid., para. 14.2.10. See also ch. 10 regarding detect and avoid (DAA).

Regulation explicitly states that operations in both categories must comply with the applicable operational requirements set forth in the Standardised European Rules of the Air (SERA).[627] The exact meaning of this statement is not clarified in the document outlining the acceptable means of compliance and guidance material to the regulation.[628] One may only assume that, without further instructions, the rules apply as they are: for example, the operator must file a flight plan.[629]

If we take into consideration the entire legal framework, though, the application of SERA must be limited to situations in which the UAS is used in airspace shared with manned air traffic. In other cases, the new rules can be seen as *lex specialis* to the *lex generali*[630] that the SERA represent. Particularly, the issues with ATC/ATM, including identification, are to be solved through the U-space concept, which is a form of unmanned aircraft systems traffic management (UTM). In U-space, drones are subject to a new system of traffic management. The concept is to be applied to all three categories of unmanned operations that take place in the U-space, albeit nothing suggests that UAS are excluded from relying on the traditional ATC/ATM infrastructure when they can follow its requirements. Such may occur in the certified as well as the specific category, though the likely expectation is preference for U-space where such is established.

The basis of the U-space concept, the emergence of which was examined in the second article of this study,[631] lies in mandatory technical features imposed on drones themselves. As already mentioned regarding airworthiness and registration, the open category demands class C1–4 drones to be equipped with a direct remote identification capability. This system broadcasts from the drone the operator's registration number and the drone's serial number, geographical position, and route course, as well as the pilot's geographical position. Besides identification, the drone must also be equipped with a geo-awareness system that contains information on airspace limitations and warns the remote pilot when the drone might breach such limitations.[632] The extent to which the given requirements apply in the specific or certified category has not been explicitly stated, as already noted regarding registration. Pursuant to EASA documents and sheer common sense, though, operating in the U-space will require the drones to have remote identification and geo-awareness features regardless of the operational category.[633]

627 *Commission Implementing Regulation (EU) 2019/947*, Art. 7, paras. 2–3. The SERA are set forth in *Commission Implementing Regulation (EU) No 923/2012*.

628 See *Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Commission Implementing Regulation (EU) 2019/947*.

629 *Commission Implementing Regulation (EU) No 923/2012*, Annex, sec. 4.

630 See, *e.g.*, Lindroos 2005, pp. 35–64.

631 Huttunen 2019a.

632 *Commission Delegated Regulation (EU) 2019/945,* Annex, Parts 2–6.

633 *EASA Opinion No 01/2020*, p. 13 (mentioning, however, only the specific category).

The actual rules on the concept will establish alternative rules concerning EU Member States, operators of UAS and manned aircraft, as well as old and new service providers. The idea, if the present proposals are followed, is that the MSs can designate volumes of controlled or uncontrolled airspace as U-space temporarily or permanently. Cross-border U-space can also be established. This will have as little effect as possible on manned air traffic, since in controlled airspace air navigation service providers (ANSPs) will remain responsible for providing air navigation service (ANS) thereto; in uncontrolled airspace, flight information service (FIS) will be given. At the same time, U-space service providers (USSPs) will do the same for drone operators in the U-space.[634]

Without delving too deep into the legal-technical aspects of U-space, it is worth pointing out that the presently proposed system is to be based on an EU-wide common information service (CIS). The service entails information exchange between ANSPs, USSPs, drones, and manned aircraft. CIS providers must be certified and designated to each U-space by the Member States, and they must be distinct from USSPs. The operation of U-space has clearly been inspired by controlled airspace. Drone operators must comply with the technical and other requirements of the space and make a UAS flight authorisation request that resembles a traditional flight plan. In terms of services, the concept requires four mandatory ones: network identification, which identifies for instance the operator, position, and route of the drone; geo-awareness,[635] which provides information on UAS geographical zones;[636] system for flight authorisation; and traffic information, which gives the drone operator information on other air traffic. There are three optional ones, including real-time tracking based on information from a variety of sources, weather information, and conformance monitoring, which examines how UAS operators comply with their obligations and the submitted flight authorisation request.[637]

EASA acknowledges that the present U-space proposals are only the first building block of the whole framework.[638] As such, they are complementary and approach the legislative demand with alternative rules. Despite this, the concept as a whole may ultimately become a transformative force in ATM. As I point out in the second article of this study, the advanced and full services of U-space do not simply deal

634 *Draft Commission Implementing Regulation on a high-level regulatory framework for the U-space*, Art. 4. See in detail *EASA Opinion No 01/2020*, pp. 11–12.

635 Pursuant to a typology suggested by my colleague Malte Krumm in a discussion, geoawareness means providing the pilot with information on virtual boundaries. It can be contrasted with geofencing, which means the creation and automatic enforcement of such boundaries through positioning technology. Meanwhile, geovectoring means specifying speeds and headings in a given volume of airspace.

636 See *Commission Implementing Regulation (EU) 2019/947*, Art. 15.

637 *Draft Commission Implementing Regulation on a high-level regulatory framework for the U-space*, Arts. 5 and 10–16. See in detail *EASA Opinion No 01/2020*, pp. 12–13 and 15–18.

638 *EASA Opinion No 01/2020*, pp. 6, 9–10, and 25

with integrating drones into the shared airspace but with the creation of a seamless airspace. Such will necessitate solutions like automatic detect and avoid (DAA) and dynamic geofencing capability for all aircraft and infrastructure, so that users can interface with one another and be immediately and flexibly allocated slots for operating in a certain volume of airspace.[639]

The complete utilization of airspace by manned and unmanned aviation is thus an undertaking initiated by drones but whose scope goes beyond the legislation of drones. Yet some disagreement exists as to how fast the transformation should take place. In EASA's view, achieving the ultimate objective of U-space, which is to prevent collisions and mitigate air and ground risks, requires the associated technology to mature.[640] Some industry stakeholders, however, emphasize that U-space segregated from other airspace should only be a temporary step as it will, in the long run, create complexity and fragmentation. UTM and ATM should ultimately converge into an integrated operational concept, a process in which digital data sources and risk assessment procedures are crucial.[641]

From an outsider's perspective, this simply appears a case of the Collingridge dilemma to which there is no right answer. Segregating U-space from other airspace certainly assumes that, as of now, integration is too large of a hurdle to overcome technologically. This is why alternative rules are enacted. Simultaneously, though, the rules assume that the sociotechnical situation will change in near future to allow a more comprehensive system of ATM. It is thus at least difficult to argue that the present proposals concerning U-space are too tied to a particular state of technology.

The possible transformation is naturally linked to other sociotechnical changes. Through U-space, the complex system of controlling and managing air traffic may, *inter alia*, become hidden (from the operator's or pilot's perspective) behind a mobile application. Such an application may allow the operator to present a flight plan and, basing on all data, issue a legally binding decision on whether the plan is accepted. Indeed, this is what the advanced and full services of the concept suggest. In light of what has been suggested generally regarding digitalization, the speed, rigidity, and automation of digital platforms may transform what is the totality of aviation safety law as a material practice. This creates a new challenge in ensuring the perseverance of essential legal values in digital law—depending, of course, on which values are ultimately valued.[642]

---

639 *U-space Blueprint*, pp. 5 and 7–8. See also *European ATM Master Plan: Roadmap for the safe integration of drones into all classes of airspace*.

640 *EASA Opinion No 01/2020*, p. 6.

641 *ASD Position Paper: The Unmanned Aircraft Systems Traffic Management (UTM) Regulation*, pp. 3–4.

642 See Tranter 2017, pp. 12–13. See also Hildebrandt 2009; Vismann 2008.

5.2.7. Similar and Distinctive Flight Rules

With flight rules, as with many other aspects, ICAO's default position has been replication. According to the RPAS Manual, both VFR and IFR apply to UAS in all aspects. In the former case, the Manual notes, the remote pilot must be able to comply with the minima concerning visibility and distance from clouds. In both cases, the pilot must identify encounters with other aircraft and take appropriate action. Meteorological conditions must be assessed, and appropriate navigation instruments and equipment must be used.[643]

Above it was noted that existing flight rules do not take into consideration the position of the drone in relation to the remote pilot. To this end, both ICAO and the EU have given legal significance to the distinction between flying within or beyond the visual line of sight (VLOS, BVLOS) of the remote pilot. The concept of VLOS was already included in *Annex 2: Rules of the Air*, but the RPAS Manual expands thereon and also uses the latter concept. In specific terms, VLOS, according to the Organization, refers to "[a]n operation in which the remote pilot or RPA observer maintains direct unaided visual contact with the remotely piloted aircraft."[644] A slightly different definition is used in the EU where VLOS signifies

> a type of UAS operation in which, the remote pilot is able to maintain continuous unaided visual contact with the unmanned aircraft, allowing the remote pilot to control the flight path of the unmanned aircraft in relation to other aircraft, people and obstacles for the purpose of avoiding collisions[645].

Despite the divergent wording, the core of both definitions is the same: the pilot is able to maintain unaided visual contact with the drone. The meaning of BVLOS, at least in the EU, is simply an "operation which is not conducted in VLOS".[646]

The distinction solves the misclassification problem with the existing rules. This is important since BVLOS is a crucial factor in making many drone applications economically viable.[647] Recognizing its existence enables developing rules that achieve a sufficient level of safety. Indeed, the RPAS Manual employs it within nearly all fields of aviation safety law, including pilot qualifications (though the Manual does not go into detail in this regard), communications, the RPS, and ATM procedures.[648] The same goes for the EU where the distinction is used as one indicator in the risk-based approach. For example, the open category almost

643 *ICAO Document 10019: Manual on Remotely Piloted Aircraft Systems*, paras. 2.3.7 and 14.2.7–14.2.8.
644 *Annex 2: Rules of the Air*, ch. 1.
645 *Commission Implementing Regulation (EU) 2019/947*, Art. 2, para. 7.
646 Ibid., para. 8.
647 *European Drones Outlook Study*, p. 10.
648 *ICAO Document 10019: Manual on Remotely Piloted Aircraft Systems*, chs. 9, 11, 12, 13, and 14.

exclusively includes VLOS operations,[649] while the risk assessment in the specific category considers whether the planned operation is VLOS or BVLOS.[650]

As explicated above, the European rules seek the replication of SERA[651] in the specific and certified category.[652] This means compliance with either VFR or IFR and with other requirements set forth in the standardized rules. Still, this approach seems only to make sense for cases in which the operation takes place among manned air traffic. Otherwise, flying drones would be subject to several rules, such as those concerning minimum altitudes, that have not been designed to control unmanned traffic. One seems obliged to interpret the provision on applying SERA so that, for instance, the new drone-specific rules represent *lex specialis*[653] or a permission from the competent authority[654] to deviate from the standardized minimum altitudes.

Otherwise, when operating in U-space, it can only be assumed that both categories will follow new, alternative flight rules as opposed to the SERA. The U-space is a distinct volume of airspace designed for unmanned aviation, and it utilizes its own set of services.[655] Replicating SERA would transplant the characteristics of the traditional system, defeating the purpose of the concept. At the very least, it seems ambiguous which SERA rules remote pilots ought to follow in U-space; the SERA ignore many key aspects, like the difference between VLOS and BVLOS, and things like IFR equipment requirements seem out of place, as U-space necessitates the use of drone-specific identification and geo-awareness features. Certainly, U-space will entail breaching traditional altitude limitations. The true integration of these separate systems, as discussed above, is still far ahead. What is needed, for instance, is a system that can translate between different altitude reference systems, standards for vertical and horizontal separation, a navigation specification,[656] and the incorporation of VLOS and BVLOS into SERA.[657]

The approach in the open category is clearer, since the category avoids integrating drones into the same airspace as manned aviation, at least for now. Because of this, drones therein comply with a fixed set of very restrictive flight rules. To be exact, these alternative rules are not designated as flight rules but operational limitations.

---

649 *Commission Implementing Regulation (EU) 2019/947*, Art. 4, para. 1, subpara. d.

650 Ibid., Art. 11, para. 4, subpara. a.

651 *Commission Implementing Regulation (EU) No 923/2012*.

652 *Commission Implementing Regulation (EU) 2019/947*, Art. 7, paras. 2–3.

653 See, *e.g.*, Lindroos 2005, pp. 35–64.

654 See *Commission Implementing Regulation (EU) No 923/2012*, *e.g.*, SERA.5005, para. f.

655 Cf. *EASA Opinion No 01/2020*, pp. 11–12.

656 This refers to the instruments and procedures used by an aircraft (and the ATM architecture) to navigate from one point to another. Examples include area navigation (RNAV) and performance-based navigation (PBN). See *ICAO Document 9613: Performance-based Navigation (PBN) Manual*; Tooley & Wyatt 2007/2018, pp. 207–222.

657 The observations stem from attending Eurocontrol discussions on the issue. They are presented in more detail in internal documents, such as *UAS ATM Flight Rules: Discussion Document*.

Some of them are general and apply to all open category flights, while some depend on the operational subcategory (A1–A3). The rules, for example, forbid flying over assemblies of people and limit the MTOM, operating speed, and maximum altitude and distance of the drone. Generally, the altitude is limited to 120 meters from the closest point on the surface of the earth, whereas limitations on distance may concern the distance from residential areas or from the remote pilot.[658] In some aspects, the operational limitations are bound to the product requirements included in the Delegated Regulation as hard-coded features. They are hence connected to the class of the drone.

For now, the alternative rules of the open category appear sensible. Yet, in the bigger picture, they give a rather static picture of the drone industry. They assume that the fixed limitations, based on the features of today's unmanned technology, provide the appropriate level of safety also in the future. If the safety and automation of drones develops rapidly, however, the rules risk being too tied to drone technology as it was around the year 2020. They might hence become over-inclusive, which means that amendments to what is allowed in the open category may be necessary in the future. Of course, this problem should not be overstated at this stage, as it applies to any technology-related legislation.

5.2.8. Ignoring Security?

With regard to security-related issues, such as the use of drones for criminal purposes or acts targeting the UAS itself, the approach of ICAO has chiefly been a mix of passivity, replication, and emulation. In terms of passivity, the Organization has made no changes to *Annex 17: Security* or other Annexes that contain SARPs on the prevention of security threats. As a matter of fact, at least one ICAO information paper cited in a treatise displays no intention to amend Annex 17 at all.[659] Despite this, the RPAS Manual contains some recommendations on security.

In accordance with airworthiness recommendations, the Manual notes that the remote pilot station is similar to a cockpit in purpose and design. For this reason, it must be secured from unlawful interference just like a cockpit. Furthermore, one must also acknowledge that the RPS is a fixed and exposed structure, which might imply that extra protection is necessary. Access to the RPS should regardless be restricted, the measures of restriction depending on the size and capabilities of the UAS. Standards for systems that control access to the station should be at least as good as in commercial manned aviation. In terms of physical security, the aircraft ought to be stored and prepared for a flight so that any tampering will be detected and prevented, while remote pilots should be subjected to the same background checks as the aircrew of manned aircraft. Overall, security procedures should be

658 *Commission Implementing Regulation (EU) 2019/947*, Art. 4, Art. 7, para. 1 and Annex, Part A.
659 Masutti & Tomasello 2018, p. 48 (cit. Spijkert & Lozano 2016).

included in the flight manual.[660] The RPAS Manual's recommendations have since been repeated in the proposal for Part IV of *Annex 6: Operation of Aircraft*.[661]

To summarize, some of the recommendations seek to replicate existing law as it is, while others aim to tailor the requirements for UAS. The Manual, however, also enacts an alternative rule by recommending that the C2 link and related services must be free from all forms of interference or hijacking. The protective requirements, it is noted, must also be harmonized.[662]

The European approach on security, as examined in the fourth article of this study, so far largely relies on measures that traditionally fall within the ambit of safety. This includes the new framework presented above, which deals with airworthiness, air operations, licensing, flight rules, remote identification, and so forth. Besides safety, the rules aim to advance security, mixing all approaches from replication to transformation. There are no special provisions that seek to protect the surroundings of the drone from its intentional misuse. It is worth noting that the SORA method of risk assessment in the specific category excludes most security considerations,[663] and the security specifications for the certified category are yet to be developed.[664] The provisions on airport security, which are perhaps the most important aspect of traditional aviation security, remain unchanged.

The suitability of the given rules on the security of drones depends on the type of drone operation and on which rules one decides to examine. In cases where the UAS is operated from an airport subject to security requirements, the approaches of passivity, replication, and emulation appear reasonable. Even in such cases, however, some issues might still require further legislation. For example, the RPAS Manual does not consider UAS-specific SARPs for the protection of passengers, baggage, cargo, and mail. This has prompted one author to suggest legislative action.[665]

The security effects of authorization and licensing requirements depend on the compliance of the end user. Already from the perspective of existing rules, it was acknowledged above that overseeing drone operators is challenging due to the

660 *ICAO Document 10019: Manual on Remotely Piloted Aircraft Systems*, sec. 9.11, and paras. 4.6.2 and 13.4.5–13.4.6.

661 Masutti & Tomasello 2018, pp. 173–174.

662 *ICAO Document 10019: Manual on Remotely Piloted Aircraft Systems*, para. 9.11.6. See also sec. 11.5.

663 *Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Commission Implementing Regulation (EU) 2019/947,* AMC1 Article 11, para. 1.3, subpara. d; *JARUS Guidelines on Specific Operations Risk Assessment (SORA)*, para. 1.3, subpara. d (it only applies to security aspects of the airworthiness of the systems).

664 See, however, *JARUS CS-UAS: Recommendations for Certification Specification for Unmanned Aircraft Systems*, *e.g.*, CS-UAS.2522 and GM-UAS.2522 (requiring UAS systems to be protected from intentional unauthorized interactions) and CS-UAS.2605, para. c and GM-UAS.2605, para. h (requiring physical security requirements to be considered for the RPS).

665 Fiallos 2019, p. 175.

distributed nature, small size, and poor identifiability of UAS. Although the new drone-specific rules on airworthiness, air operations, licensing, and so forth differ beneficially from existing ones, in terms of security the key problem remains the same: compliance. Hard-coded limits on operational altitude, geographical location, and airspeed depend less on the end user but are still subject to hacking. Besides, there are already millions of low-security drones flying around. Solving the issue is not as simple as subjecting drones to airport security, as the very benefit of drones is that they can be immediately used at remote locations. The security shortcomings of the existing law in relation to drones has thus been largely ignored, mostly due to the focus on creating the framework for benign operators. To this end, the last article suggests adopting anti-drone technology at airports and other critical locations.[666]

The described rules are supplemented with rules that oblige the operator to protect their drone from interference. In the open category, the command and control link of class C2 and C3 drones must be protected against unauthorized access.[667] Otherwise, though, the category does not oblige the operator to secure the drone. In the specific category, on the other hand, the operator must establish measures to protect the UAS against unlawful interference and unauthorized access. Additionally, the operator has to establish procedures ensuring that the security requirements applicable to the area of operations are complied with. Both obligations must be adapted to the intended operation and its risk.[668] These rules are alternative as they do not replicate or emulate existing standards on securing the aircraft. Since the intended security rules for the certified category, which seems the one most threatened by interference, are yet to be drafted, there is not much to criticize about the approach.

666 Huttunen 2019c, pp. 96–98.

667 *Delegated Regulation (EU) 2019/945*, Annex, Parts 3 and 4.

668 *Implementing Regulation (EU) 2019/947*, Annex, UAS.SPEC.050, para. 1, subparas. ii and iii.

6. Conclusions

6.1. General Contributions

6.1.1. Purpose and Approach

The purpose of this study has been, on the general level, to discuss the following main questions:

I. What issues can sociotechnical change cause in relation to existing law?
II. What legislative approaches can be used to solve the issues caused by sociotechnical change?

To discuss the general questions, the study has examined the increase in unmanned civil aviation in European airspace during the 21st century as a case. Hence, the questions have chiefly been dealt with in the following, more specific form:

I. What issues has the increase in unmanned civil aviation caused in relation to existing aviation safety and security law?
II. What legislative approaches have ICAO and the EU used to solve the issues caused by the increase in unmanned civil aviation?

This synthesis and the articles have sought to answer the questions first on the level of legal doctrine. As a preliminary matter (the first article), this has entailed analyzing the meaning and scope of concepts used to describe unmanned aircraft systems. For the most part (the other articles), it has involved creating a concise and systematized presentation about the key aspects of existing international and European aviation safety and security law, and analyzing how drones fit the framework. Furthermore, the study has created a similar presentation about the developing international and European drone-specific aviation safety and security law, comparing it to the legislation that precedes it and examining some of its strengths and weaknesses.

Besides legal doctrine, the synthesis of this study has attempted to answer the overarching questions on a theoretical level. This aspect of the study draws upon case study methodology. It views UAS not only as subjects of aviation safety and security law—the targets of such legislation—but instead a case of sociotechnical change in civil aviation. Theoretically speaking, drones are a case of the typical legal issues caused by sociotechnical change and a case of the typical legislative solutions to the issues. In this regard, the study has involved theoretical guidance in that it has used generalized typologies to bring out the relevant aspects of the case. Additionally, though, the study has involved theoretical testing and development. This is because it has attempted to examine the accuracy of existing typologies about the legal issues and to develop those typologies and, finally, to develop a new typology about the legislative approaches to sociotechnical change.

From a theoretical standpoint, the study shows that existing typologies of legal problems caused by sociotechnical change are applicable also in the context of civil aviation. However, the study equally shows that the typologies can be developed from both an abstract perspective (and using the examples given by earlier authors) as well as from the perspective of the present case of drones. This has led to the adoption of an enhanced typology that includes eight issues. The first possible issue is vacuity (the lack of applicable rules), while the other seven can occur when trying to apply existing rules: misclassification, over- and under-inclusiveness, irrelevance, ineffectiveness, injustice, and value conflict. These all represent a possible cause for legislative action. The testing and development of the new typology in other contexts of sociotechnical change remains, of course, a task for future studies.

As legislative approaches, the model recognizes five: passivity, replication, emulation, alternative rules, and transformation. The choice between different approaches depends on the issues with existing rules but also on other factors, like practical aspects and values. Practical aspects may include time, resources, and the prevalent political situation, while the concept of values includes matters such as safety, sustainability, economic equality, and so forth.

By combining these two aspects, the study has sought to develop a model of legislation and sociotechnical change, using the case of drones to highlight both. Since the relationship between legislation and sociotechnical change is better understood as a process, the model is not merely limited to describing issues and solutions. Instead, its purpose has been to participate in the development of a broader theory of law and sociotechnical change. For this purpose, the model moves into the territory of regulatory theory by introducing certain preliminary questions that should be appraised whenever the legislator considers enacting rules on new technology and its related practices.

6.1.2. Sociotechnical Change

The starting point of the model is to ask whether a sociotechnical change is truly occurring. This is a difficult question, since it requires gathering factual evidence of three elements: the technical, the social, and the change. In other words, the existence of for example legislative projects does not by itself mean that a change is occurring. Other factors that can also affect our perception of there being a change include values, the public opinion, and existing law. Due to such reasons, the existence of a sociotechnical change can be mistaken as there being none, or vice versa, which suggests that the legislator must carefully assess the facts. The present study has approached the question by building a factual case in the Introduction and Chapter 4 on the sociotechnical change created by the increase in unmanned civil aviation.

The first element of sociotechnical change refers to technology. While the concept of technology is contested, one useful way of defining it is to refer to tools, techniques, products, or processes that extend human capability. In the context of unmanned civil aviation, as examined in the study, the technical naturally refers to unmanned aircraft systems, which extend the human capability to operate in the airspace. Consumer grade drones are most accurately characterized as products, while drones designed for professional flying can be regarded as tools. In either case, the possibility of doing things such as sheer flying, photography, or transporting goods is expanded.

By itself, modern conceptions of technology already recognize that technology is something more than mere objects. However, this is emphasized by the conceptual move from technical or technological to sociotechnical, which means that changes never concern only artefacts but also the related human behavior. The development and use of technology are socially constructed processes: technologies and their users shape each other. In the case of drones, the element of the social is already present in how drones enable certain new forms of aviation and enhance existing ones. The new aircraft alone are not the objects of interest; instead, the change takes equally place in the activities allowed by them. The study has also noted the ways in which the developing rules on drones can affect the technology, which demonstrates a reciprocal relationship.

The final element of sociotechnical change is, of course, change. Change can either refer to substituting existing technology, altering it, finding new ways of using it, or introducing new technology. As there is a persistent stream of technological progress, meaningful discussion necessitates the existence of a change that is clearly distinguishable. In the present study, such a change has clearly been demonstrated in Chapter 4 by factual evidence on how unmanned aircraft systems (and thus unmanned civil aviation) differ from their manned counterparts. Besides the obvious difference concerning the location of the pilot, drones are generally cheaper, simpler to operate, more plentiful, harder to identify, and they can be flown from any location. Of course, it must equally be recognized that some drones are quite similar to manned aircraft in their characteristics.

Since this study has examined a sociotechnical change, it has not elaborated on cases where no change is occurring or is perceived to occur. In these situations, the model developed here regardless suggests that the legislator should adopt a passive approach. Naturally, some factors like as stakeholder pressure can still cause the legislator to act in such situations, and future sociotechnical developments necessitate re-examining the factual side of things. This simply means that the process is never exhausted by resorting to passivity at some point.

6.2. Legal Issues

6.2.1. Misclassification

The acknowledgement of a sociotechnical change requires the legislator to consider the application of existing rules. In doing so, the legislator must take into account legal rules that are connected to the sociotechnical situation in question and thus could apply. Given the focus of the present study on the safety and security of UAS, it has naturally analyzed the possibility of applying existing law on aviation safety and security to such aircraft. These are rules that are connected to drones, albeit their exact relationship has necessitated a more detailed analysis.

The overall conclusions concerning this analysis are manifold. In certain limited respects, the study has found no issues in applying existing rules as they are. This goes mostly for unmanned aviation that utilizes high end aircraft and operates from aerodromes, resembling manned aviation in most of its characteristics. In many ways, however, the increase in unmanned aviation has caused issues of misclassification, over-inclusiveness, under-inclusiveness, and ineffectiveness in relation to the existing rules on aviation safety and security. These issues may not have actualized in legal practice, but from the perspective of legislating the technology the issues reveal themselves regardless: an attempt to apply such rules to would lead to the given problems. Furthermore, the increase in unmanned aviation suggests that, down the line in the development of drones, some of the existing rules risk being increasingly ineffective and perhaps even irrelevant, losing their justification altogether.

The issue of misclassification means that existing rules wrongly classify some aspect of the changed sociotechnical situation. This has been perhaps the most recognizable issue in the legislative project concerning drones. The most obvious example of the problem lies on the terminological level: there has been a challenge to find a proper term to describe aircraft flown without a pilot on board the aircraft, and to define the term appropriately. This study recognizes that many traditional terms have failed to classify modern drones. Concepts like model and toy aircraft are insufficient because they exclude non-recreational purposes, such as agriculture, geology, and professional filmography, for which drones are increasingly developed and used for. The concept of unmanned aerial vehicle fails because drones are aircraft, and we should not generally employ the term "pilotless aircraft" of Article 8 of the Chicago Convention, since drones are nearly always piloted.

Besides terminology, the categorization schemes for air operations have risked misclassifying unmanned aviation. While the categories might work for the largest and most demanding kind of activities and/or at the international level, they fail at classifying the most popular types of drones and their uses. This includes drones with an MTOM of a few dozen kilograms or less, which are in many cases used in semi-professional settings. ICAO's exclusion of aerial work has itself been a problem for drones. Meanwhile, EU's original operational categories use distinctions like complex and non-complex aircraft, which are usually not as crucial for unmanned as they are for manned aviation. The concept of CAT, in the case of drones, involves scenarios that are very different from traditional ones.

The case of airworthiness is also relevant in this regard. Not even the airworthiness of the most high-end drones is completely addressed by traditional rules, since there are new components to safe operation: there has hence been a lack of applicable rules. The risk of misclassification chiefly concerns the remote pilot station, since existing rules seemingly fail to classify it. The RPS is a curious thing, though, as one may equally claim that the existing rules on the flight crew compartment can be applied to an extent.

Present flight rules, too, seem to wrongly classify unmanned aviation. The traditional distinction between VFR and IFR can, in principle, be applied to the operation of drones. One can fly by visual cues by observing the drone from the ground, or by using a first-person view. Flying solely by instruments is also possible. Still, VFR/IFR cannot serve as the only distinction, as both rulesets have been created with manned aviation in mind. They are, by default, based on the idea that the pilot is on board the aircraft. Most importantly, VFR and IFR fail to acknowledge the distinction between the drone being VLOS or BVLOS, which has a dire impact on the overall nature, technical specifications, and risks of the operation.

6.2.2. Over- and Under-Inclusiveness

Substantively, the biggest issue in applying existing rules has been the threat of subjecting drones to rules that are disproportionate to the risks of most unmanned aviation. In accordance with Bennett Moses's typology and the one used here, the problem qualifies as over-inclusiveness: the rules (would) include behavior they should exclude. In the case of air operations, for example, most existing requirements can be followed in cases where the operation of the UAS resembles manned aviation. In the case of commercial passenger transport using drones, for instance, there is no reason to deviate from regular operational standards when they make sense despite the technical differences. UAS carriers can be certified just like other air operators, apart from cases in which the transport is so low risk that it does not necessitate certification. In most aerial work, however, the actual rules would be over-inclusive if applied to all UAS simply because they are designed for manned aviation. Of course, the legislation also lacks applicable rules for drone-specific aspects of the operation.

The issues with airworthiness, though rather complex, also illustrate the threat of over-inclusion. There are certainly UAS that could and should follow the existing system of type and airworthiness certification and continuing airworthiness. This goes for drones whose operation comes close to manned aviation in terms of risk and purpose, including for instance human transport. Furthermore, EU's essential airworthiness requirements are not over-inclusive, since they are so generic. The whole scope of unmanned aviation, however, includes operations for which the traditional airworthiness instruments would be vastly over-inclusive. The risks presented by many drones do not necessitate the system to be subjected to a full certification procedure nor to comply with comprehensive rules on aircraft maintenance.

Over-inclusiveness is equally a risk in the registration of aircraft. There are simply too many drones around and purchased all the time to be registered by traditional means. The lifespan of drones is also much shorter than that of manned aircraft, and they are traded frequently, which would create additional work and could cause misleading registry entries. This would be an issue even if the registration procedure, which currently is rather encumbering, were changed entirely. Besides, unless the purchase of drones is controlled somehow, there is no way to ensure that the aircraft is registered. Most importantly, though, safe aviation does not require them all to be registered as individual aircraft.

The same issue exists with the licensing of pilots and other personnel operating the drone. Many of the existing requirements concerning the competency of the crewmembers are reasonable, and many remote pilots certainly need several of the theoretical and practical skills necessitated by existing rules. For instance, there is no problem in applying rules that require pilots to go through training in the basics of flight planning. It is not, however, sensible to apply the whole spectrum of existing standards to all remote pilots. Pilots who fly certain types of commercial drone operations do require training similar to pilots of manned aircraft, including simulation, instructed flying, and examinations. At the same time, most drones, even many professional ones, are easy and safe to operate without training. While this does not mean that they should be exempted from all training, traditional procedures appear over-inclusive particularly when the operational risks are much lower.

Problems with ATC/ATM display a mixture of under- and over-inclusiveness. Drones have obvious issues with the existing rules on airspace, which are both aircraft and airport centric. Although some commercial unmanned aviation is and will be designed to operate using the same aerodromes and airways as manned aircraft, most UAS are not. Their ability to take off from and land at almost any location and their preference for flying low means that they cannot benefit from ATC services provided at airports and in air corridors. The existing rules thus seem under-inclusive, as they exclude unmanned aviation like they should. Yet one cannot simply solve this issue by extending traditional control measures to airspace populated by drones. This is because UAS mostly lack the communicative capabilities of manned aircraft, and requiring them to acquire such capability would be over-inclusive in terms of cost. Besides, the human-centric ATC/ATM system would not be able to handle all drone traffic, resulting in over-inclusiveness from a practical standpoint. To control mass unmanned aviation, particularly in urban areas, the issue has to be solved through new technology and rules.

Over-inclusiveness is also a threat in several other issues. For instance, requiring all drones to be equipped with a regular transponder would be over-inclusive given the size, price point, and operational environment of most drones as well as the desired level of aviation safety. On a related note, other navigation equipment and instruments required to comply with IFR rules are also out of reach for most UAS, as such requirements are largely based on the traditional framework of ATC/ATM. There are explicit problems, too, with provisions like minimum flight altitudes, which range from 150 to 600 meters depending on the followed rules and location. Such minima are over-inclusive in relation to UAS, since drones are usually designed to fly precisely at low altitudes, and since they pose less of a ground risk than manned aircraft.

In some respects, like aviation law that particularly deals with security threats, existing rules actually appear under-inclusive. This law is notably airport centric, since it includes measures like security restricted areas, security checks, the screening of passenger, baggage, and cargo, and camera surveillance. The core objective is to prevent dangerous persons and items from entering into civil aircraft in the first place, but the rules also enhance the capability of the aircrew to deal with security threats during the flight. Rules on the latter aspect are somewhat applicable to unmanned aviation, too, as the RPS has to be protected from malicious interference. Security checks and screening, however, only improve the security of drones that operate from airports. They do not help prevent malicious acts in cases where the drone operates outside airports, which goes for the vast majority of cases. Since the vast majority of drone operations are also of much lesser risk than the manned operations subject to the given security measures, the issue ought not to be exaggerated. Still, the issue is worth pointing out with regard to UAS passenger transport, as such application does have its risks and is mostly (at least for now) carried out outside aerodromes.

6.2.3. Ineffectiveness and Other Problems

Many of the issues caused by the unique characteristics of UAS and their operation highlight the ineffectiveness and lack of existing rules. Among other aspects, there has clearly been a lack of rules applicable to the data/C2 link(s) used to control and command UAS, since such a feature is not present at all in manned aviation. Ineffectiveness is also the core issue with UAS and the existing framework on ATC/ATM. There is not exactly a complete legal vacuum, since we do have a system for the purpose. However, the framework we have fails to advance safe and orderly air traffic in low level airspace where it is needed for drones, and it does not address the interfacing between drones, manned aircraft, and existing aviation infrastructure. In this regard, there is both vacuity and ineffectiveness.

The manner in which visual flight rules ensure safe aviation could also be regarded as ineffective when drones are concerned. In drone operation, the sensory cues during the flight are reduced or non-existent, which challenges the ability of the remote pilot to maintain awareness, identify hazards, and take appropriate action in due time. This goes for all UAS, not just the most typical ones. Again, there basically are existing applicable rules in the form of ICAO rules of the air and SERA. However, these VFR and IFR are not simply under-inclusive but ineffective in enabling the safe operation of drones below the given altitudes, since they do not consider the characteristics of unmanned aviation.

Rules on the identification of aircraft are also ineffective in the context of drones. Above, this study has observed that registration and nationality markings do not actually aid in identifying most drones, since both the aircraft and the markings are so small. Similarly, conventional primary radars can mistake drones for birds and regardless filter out clutter like birds and drones, as small airborne objects can distract the air traffic controllers from their primary task. Naturally, these problems do not concern the most advanced drones and demanding operations in which the drone is large enough to be identified and is equipped with the devices that enable it. But, in most cases, rules that rely on visual recognition and radars are ineffective and ought to be supplemented with other measures.

Existing rules that advance aviation security are also ineffective when it comes to unmanned aviation, since they rely quite a lot on the operational characteristics of manned aviation. To begin with, this applies to the spillover security effect of safety rules. For instance, rules on air operations, airworthiness, and pilot licensing deter the misuse of aircraft because manned aviation commonly necessitates a predetermined location for take-off, landing, and maintenance, and because flying is expensive and difficult. Manned aircraft are also readily identifiable. In unmanned aviation, the rules only deter misuse when the characteristics of the operation are similar. In most cases, though, the rules yield few to no security benefits because UAS are hard to identify and can be operated without training, covertly, and from nearly any location. In other words, the rules are not very efficient in securing the environment from the misuse of drones.

The increasing use of civil UAS in European airspace has not yet caused existing rules to appear irrelevant or unjust. This is largely because the legacy framework of aviation (law) is still extremely paradigmatic: the great majority of aviation is manned aviation, and the greatest benefits of aviation still lie in that framework. The sociotechnical change taking place does not presently threaten the hegemony of manned aviation. Yet there are hints that, in the future, some aspects of the legacy legal framework may fade into irrelevance. These hints, for the most part, concern how air traffic is controlled and managed. If sociotechnical change leads to a possibility for a more efficient system through digitalization and automation, as is expectable, conducting traditional ATC/ATM may at some point become less important. Ultimately, the traditional system may face irrelevance if there are no longer aircraft that require an aerodrome for take-off, landing, and maintenance, or human guidance in air navigation.

In the discussion in Chapter 4, no observation was made of a value conflict between drones and existing aviation safety and security law. This is because the characteristics of drones do not ultimately challenge the very values of such law: safety (including security), which serves the freedom of movement, as well as the use of natural resources for the latter purpose. These notions retain their importance in spite of the sociotechnical change caused by the increase in unmanned aviation.

Drones can and do raise new and well-known threats to the everyday safety and security of civil aviation, and they may inadvertently advance new values such as the importance of data. However, their increasing use does not question the existing values themselves. Safety is still the cornerstone of air law, whether it concerns manned or unmanned aviation. The matter is mostly about deciding what kind of legislation can achieve the desired level of safety, considering the risks presented by drones. A distinct issue, which is not discussed here due to the study's focus on aviation safety and security law, is whether increasing urban mobility can challenge other values embedded in other legislation. This theme is naturally worth exploring, and not only in the context of law.

6.3. Legislative Approaches

6.3.1. Passivity

In addition to further improving our understanding of legal issues caused by sociotechnical change, the case of drones also provides a basis to improve our understanding of the legislative solutions adopted to manage sociotechnical change. The latter development falls within the broader context of technology governance, representing a subset of it. The study has partly utilized existing efforts to categorize legislative solutions but mostly has developed its own terminology to that effect. This is because the existing efforts appear either too broad, concerning the whole scope of regulating technology, or too narrow, not recognizing certain types of legislative approach. To reiterate, the approaches identified and exemplified (using the case of drones) in this study include passivity, replication, emulation, alternative rules, and transformation.

To answer the second research question, historically speaking, passivity has been the most prevalent approach in legislating the safety and security of UAS—at least if we focus on written law. At the international level, for a long while since the adoption of the Paris and Chicago Convention, it was considered unnecessary to issue any rules on the topic. No Annexes to the latter Convention were amended to address unmanned aviation. At the European level, drones with an MTOM of less than 150 kg were excluded from the scope of EU rules until 2018, and there were few or no rules for those exceeding the threshold. The legislative project at both levels has only started since after the year 2000 and in a serious manner only during the 2010s.

The historical point, however, is somewhat moot because the sociotechnical change involving drones has only begun recently. Hence, passivity can only be regarded as an approach to such change in the context of the past two decades. In this context, the recent legislative project has contained elements of passivity as inability. This simply means that the issues caused by drones, particularly in relation to the use of airspace, are so complex that it has not been possible to solve them right away. This has nothing to do with the competence of the legislators but rather the fact that the sociotechnical change in mobility is still ongoing. While the typology of legislative approaches does not incorporate the question of appropriate timing (of legislative action), one must acknowledge its impact: the dangers of issuing new rules too soon are well-known.

Besides inability, passivity has been employed as a conscious approach. The most obvious example is ICAO's decision to leave the formulation of "pilotless aircraft" as it is, claiming that all UAS fall within the scope of Article 8. ICAO's reading is quite fragile in terms of treaty interpretation but makes practical sense, as it avoids the task of amending the provision for the purpose of drones. On another note, the concept of model aircraft has been implicitly accepted as a national category of recreational drone use but excluded from the scope of ICAO's SARPs. This can also be regarded as a passive response on behalf of the Organization.

Security questions have been treated with some passivity both at the international and European level. Albeit rules to protect the UAS itself have been issued and are still being developed, neither ICAO nor the EU has chosen to enact standards that would curb the misuse of drones. ICAO has, for instance, no plans to make amendments to Annex 17 that particularly concerns security. The European approach, on the other hand, relies on safety rules to simultaneously improve security, while the core of security remains attached to the airport context. This means that drone operations using airports will be as secure as manned aviation but others not. The matter has been left to be solved at the national level, possibly outside the context of air law.

6.3.2. Replication and Emulation

Both ICAO and the EU have approached many of the aforementioned issues through the replication and emulation of existing rules. Terminological choices demonstrate emulation. ICAO has differentiated between remotely piloted and autonomous aircraft as two subcategories of UA, thus far including only RPA(S) within its scope. There are reasons to criticize such an approach, as the distinction between RPA and AA is not clear-cut at all. Regardless, we are dealing with the tailoring of the existing concept of aircraft to acknowledge the characteristics of unmanned aviation. The EU's preferred new term is UA(S), which includes both RPA and AA of all grades of autonomy. While the idea of "unmanned" aircraft seems misleading, it is a simple concept that avoids setting definitive thresholds for remote piloting and autonomy. Sensibly, it also serves as a counterpart to "manned" aircraft. The present study thus endorses UAS as the general concept along with the concept of "drone", which is mostly utilized because of its popularity and conciseness.

Substantively, replication and emulation have been especially popular at ICAO, since the Organization has implicitly limited its scope to such unmanned aviation—international and BVLOS (IFR)—that comes closest to manned aviation. Hence, the RPAS Manual for instance seeks to understand drone operations in terms of commercial air transport and general aviation, as before. Substantively, the Organization has resorted to emulation by introducing the concept of RPAS operator certificate. The ROC, while comparable to the AOC, is intended to be issued not only for commercial air transport but for international aerial work, too. Other responsibilities imposed on the operator are also emulated from existing aviation safety law and are very generic in nature, essentially demanding no more and no less than in manned aviation.

Airworthiness-wise ICAO has thus far recommended the replication of existing airworthiness rules. Indeed, the Chicago Convention leaves little room in this regard because it requires every aircraft in international aviation to hold an airworthiness certificate. To the maximum extent practicable, the rules on type certification, production approval, continuing airworthiness, and product modifications should be applied. Distinct certification schemes are envisioned for other components like the remote pilot station and the command and control link, mixing emulation and alternative rules. Neither the RPS nor C2 are to be independently certified but rather as part of the aircraft's certification. As the RPS resembles the cockpit, the rules on the latter can be emulated.

Essential airworthiness requirements of the EASA Basic Regulation, due to their generic disposition, are replicated and emulated in the rules on UAS. The drone rules contain elements of traditional requirements, which have slightly been tailored to, *inter alia*, take into account the broad scale of drone operations. The rules on airworthiness certification are emulated in the context of drones, but in a limited manner. Only drones passing one or some of predetermined thresholds are subject to certification: this includes, for example, drones with a characteristic dimension of 3 meters or more and drones designed for human transport. The operation of such UAS falls within the scope of the certified category, although the specific category allows the use of certified drones, too. The idea is to base certification on existing regulations, but naturally the unique characteristics of drones necessitate some alterations. The exact nature of the changes is yet unknown, although JARUS has already drafted a proposition thereto.

The obligations imposed on UAS manufacturers in the open category are also a case of replicating and emulating existing obligations. These obligations derive their content from a general decision that seeks to ensure the quality of products marketed within the EU. Meanwhile, some of the operational limitations imposed on drones also bear resemblance to the ones used in manned aviation, as manned aircraft are also categorized using MTOM limits. The limits used for drones are different, but the idea is the same. In the specific category, apart from cases in which a certified drone is used, airworthiness aspects are handled as part of the overall risk assessment. While this assessment is an alternative instrument, many operational safety objectives of the assessment find their basis ultimately in traditional airworthiness certification.

ICAO's approach to the registration and marking of UAS has been the replication and emulation of existing rules. Internationally, this is quite the only choice, as the Chicago Convention requires aircraft flying internationally to carry markings that indicate their registration and nationality. According to the new SARPs, markings themselves can be placed on the UA slightly differently, which signifies emulation. In the EU, registration of the drone and markings thereon are only required when the airworthiness of the aircraft is certified. Outside such cases, the UAS operator must register itself in all categories, apart from when they use the very smallest of drones. Since a single operator can operate a number of drones, the problems of traditional registration are avoided. The registry is also designed as digital and interoperable, forming the basis for remote identification. This approach contains elements of both emulation and alternative rules.

With regard to pilot licensing, ICAO has decided that the pilot-in-command must hold a remote pilot licence in international unmanned flights that follow IFR. This approach is unsurprising, given that the Chicago Convention requires pilots in international aviation to be certified and licensed. The right to pilot a particular type of UAS is determined by ratings. Emulation is also the approach regarding the substantive training requirements, like knowledge of air law and navigation aids.

The EU also relies on emulation with the essential requirements on remote pilots. In a generic manner, any person involved in flying drones must possess the required knowledge and skills proportionate to the risks of the operation. The certified category of operations appears to continue this approach, as the new rules dictate that the remote pilot should be licensed where applicable. On the other hand, the open category requires no licensing, but the training covers topics like airspace restriction, so there are elements of existing rules. The exact competency required in the specific category is determined through the risk assessment procedure and set forth either in the operational authorization or the standard scenario. While the SORA method does not explicate the exact training requirements, another JARUS document does and may be used as a basis for future legislation. Enacted EU rules explicate certain minimum requirements, such as that the pilot must be able to manage aeronautical communication.

Since the issues of low level airspace use are less prominent in international aviation and because enacting standards on a developing technology is risky, ICAO has not really undertaken the task creating a UTM system. By means of replicating rules, UAS are required to follow the existing performance, equipment, communication, and procedural requirements of the airspace where they operate. Alternative rules need to be devised and drone technology needs to be developed merely so that drones can comply with the given requirements. Changes in the system itself have not been considered. The approach has naturally been the same in terms of identification measures

The validity of the VFR/IFR distinction has been replicated both at the international and European level. ICAO recommends applying both VFR and IFR to UAS in all aspects, including obligations like the use of appropriate navigation instruments. As the Organization is not concerned with low level domestic operations at the moment, the approach is understandable. The EU's approval of the SERA in the certified and specific category follows the same approach, although again one must acknowledge that EASA is simultaneously pushing for the development of the U-space concept.

6.3.3. Alternative Rules and Transformation

The approach to enact alternative rules has been just as common as replication and emulation, though such rules have thus far been mostly devised by EASA rather than ICAO. Alternative rules have, first of all, been drafted for legacy model aircraft clubs. These clubs are, pursuant to EU rules, allowed to continue operating quite as they have done due to exemptions from rules otherwise applied to drones. This represents a sound compromise between two ill-advised extremes: retaining model aircraft as a separate category or subjecting them to exactly the same rules as all drones.

ICAO's RPAS Manual notes that an alternative risk-based categorization of unmanned operations is necessary, suggesting that the aforementioned replication of the distinction between CAT and general aviation will not hold. Meanwhile, EASA has already responded with its tripartite categorization of unmanned air operations into open, specific, and certified, which attempts to solve many drone-related issues. The first two categories tackle the issues of misclassification, over-inclusiveness, ineffectiveness, and vacuity by enacting new rules for the lower end of the spectrum. The third category mostly responds to the cases where applying existing rules is not problematic.

The open category follows an alternative set of operational limitations that supplant the obligation for any kind of approval in the form of AOC, ROC, or declaration. The specific category has its own, alternative method of approval, as the operator must either declare its compliance with a standard scenario or acquire an operational authorization through risk assessment. The SORA method by JARUS is the most well-established and perhaps thus far the only structured way of doing the assessment, having been designated as an acceptable means of compliance by EASA. Naturally, many elements of the method, like distinctions between different risk classes and safety levels, are alternative rules themselves. The certified category maintains a place for commercial use cases like passenger and cargo transport. Whether, however, existing categories like CAT, SPO, and NCC should be replicated in the rules on certified category operations remains to be seen. It is possible that a wholly alternative ruleset will be established for such operations.

In terms of airworthiness, there are alternative rules, too. Internationally, ICAO has established that the airworthiness standards for the C2 link will have to be devised separately as alternative rules, despite the link will be certified as part of the UAS. In the EU, many mandatory features required of drones in the open category are unique to drones. Among other things, drones are required to be equipped with systems for data link recovery, remote identification, and geo-awareness, which are not present features of manned aircraft. In the specific category, the risk assessment similarly addresses elements that are unique to unmanned aviation.

The same goes for the training of remote pilots. Although the main approach in this regard has been emulation, ICAO has issued alternative training rules for aspects that are unique to drones, like the C2 link and the RPS. At the same time, EASA has re-imagined some basics, too. The open category requires the remote pilot to complete an online training course and pass a theoretical exam instead of undergoing traditional licensing. Some of the topics covered by the course, such as data protection and UAS general knowledge, are alternative also.

An alternative element introduced into flight rules is the distinction between VLOS and BVLOS. Both ICAO and the EU have adopted the latter two terms in nearly all aspects of drone legislation. In the EU, for instance, the open category is almost exclusively restricted to operations within VLOS. The flight rules—or, more accurately, operational limitations—of the EU's open category are overall alternative to existing ones. These are much more restrictive than other rulesets. *Inter alia*, it is forbidden to fly over assemblies of people, and the MTOM (ranging from 250 g to 25 kg, depending on the class) and maximum altitude of the drone (120 meters above ground or take-off point) are limited. The latter two limitations naturally correspond with the mandatory features of the drone design, as explicated in the context of airworthiness, creating a system of premade operational concepts. Whether the present rules of the open category are future proof remains to be seen, as developments in safety and automation can significantly reduce the risks posed by off-the-shelf drones.

The U-space concept of managing drone traffic is, naturally, a collection of alternative rules. This is a new volume of airspace where, instead of traditional ATC, a special set of identification, geo-awareness, flight authorization, traffic information, and other services are provided to facilitate unmanned aviation. It seems reasonable to assume that the rules in that space will be *sui generis*, given that the whole volume is designed for drones and has its own services. At the very least, it seems questionable to start with the idea that the traditional SERA should be complied with in U-space. IFR equipment requirements, for instance, surely are not followed as the space necessitates the use of drone-specific identification and geo-awareness features.

EASA MSs, alone or together, can designate U-space wherever they want, and services therein will be provided by U-space service providers. Controlled airspace remains the realm of traditional air navigation service providers. The U-space operates on the basis of a common information service in which ANSPs, USSPs, drones, and manned aircraft exchange information. These are all distinct rules.

The basis of U-space lies in the aforementioned provisions that impose certain mandatory technical features on UAS. This includes, most importantly, direct remote identification and geo-awareness, which should solve the problems in identifying drones. The former means that the UA broadcasts constantly information about its operator, its position, route course, and the pilot's position; the latter means that the system warns the pilot when the aircraft is about to enter into airspace which it should not. These features are required across the open category, apart from the very smallest of drones. Similar features will naturally be required in the other two categories, when such operators wish to operate in the U-space.

The present proposals on U-space are alternative rules, as they establish the airspace alongside the existing segments of airspace. Regardless, in the future, the concept has potential to transform the entire approach to air traffic control and management. This is evident from how EASA envisions the advanced and full services of the concept as involving automatic DAA and dynamic geofencing, which would be embedded into the present infrastructure, too. If and when the technology matures sufficiently, U-space allows itself to develop accordingly, perhaps at some point merging into or overtaking the existing framework. Such changes are, of course, linked to general sociotechnical developments.

Security-wise, ICAO has made some alternative recommendations. These suggest securing the RPS and the C2 link themselves from any interference, calling for measures that control access to the station and the link. The rules ought to cover both the physical and cyber security of the system. To the same end, the EU has required class C2 and C3 drones in the open category to be protected against unauthorized access; in the specific category, the operator has an overarching obligation to protect the UAS against unlawful interference and access and to ensure compliance with security requirements pertaining to the area of operation. Security in the certified category will likely follow ICAO standards.

In terms of protecting the surroundings from the drone, the European approach largely relies on the spillover effects of certain safety rules, which are alternative or based on existing ones. For example, the open category employs the mandatory remote identification feature and hard-coded limits on operational altitude, geographical location, and airspeed. The problem with these measures is that they depend largely on the compliance of the end user. For example, it is up to the operator to register itself and to input its registration information into the drone, and rogue pilots may be able to bypass the limitations as they have done before. Furthermore, such limitations can only be imposed on future drone products, not existing or self-assembled ones. Ultimately, the only way to protect airports and other critical locations from the misuse of UAS is to adopt anti-drone technology either on a voluntary basis or through novel alternative rules.

The legal documents drafted by ICAO show virtually no attempt at transformation. The basic position is that drones must either conform with existing rules for international flight, or that alternative rules (concepts, procedures, and instruments) must be established. This is visible in all amendments to the Annexes of the Chicago Convention, as well as in the RPAS Manual. In fact, one of the guiding principles for the Organization has been that UAS must be integrated into existing rules without negatively affecting manned aviation. Hence, for example the integration of UAS at aerodromes should not place new burdens on manned aircraft. One of the few "transformations" the Organization recommends is providing changes and additions to terrain and obstacle databases.

The difficulties of transformation are apparent at least in the case of drones. The traditional system of aviation safety and security law contains numerous layers built since the adoption of the Chicago Convention in 1944. Indeed, there exists a kind of sedimentation—an ancestral spirit—in the rules, which makes it hard to reimagine the system entirely. Overcoming this sedimentation, if such is ultimately necessary, will require significant legislative efforts.

6.4. Final Remarks

6.4.1. Conflating Issues

As elaborated on above, this study provides evidence that supports generalizations about the legal issues created by sociotechnical change. In accordance with the typology developed here, there has been a lack of applicable rules (vacuity), the risk that the existing law wrongly classifies some aspects of drones or their operation (misclassification), the risk of applying to drones rules that should exclude them (over-inclusion), the risk of existing rules not applying to drones even if they should (under-inclusion), and the problem of existing rules being ineffective in the new sociotechnical situation that includes unmanned aviation (ineffectiveness). With a view to future, the study also shows that there is a clear risk that some rules will either become less important or even irrelevant through further sociotechnical change in aviation. Such categorizations enable contextualizing the case of drones, connecting it to other cases of sociotechnical change. This, I argue, will help recognizing issues and legislating them appropriately.

Despite this, the study equally demonstrates that the distinctions between various issues are not always clear-cut but blurry. Additionally, certain new technologies or particular aspects thereof can cause multiple legal issues at once. Consider, for instance, the case of the remote pilot station. The RPS is something which existing rules seem to fail to classify: it is not quite the same as a cockpit. At the same time, it is quite similar, which is why applying some rules on cockpit appears unproblematic. On one hand, the rules misclassify the RPS as a cockpit, but on the other hand they do not. Recognizing the real problem might therefore not be as simple as one might first assume, which questions the value of the typology—indeed, any typology in this context.

The case of air traffic control and management displays a similar problem with the categorization of issues. The lack of any service in low level uncontrolled airspace and the lack of services available to most drones in general suggests that the problem is under-inclusiveness: present ATC/ATM excludes activity it should include. However, this is not really the main issue, since the lack of services cannot be solved by including drones within the scope of the traditional human-centric air traffic system. The problem ultimately is that the legacy system is overall ineffective in handling large amounts of low level and low risk unmanned traffic, particularly in urban environments. Simultaneously, there is a lack of applicable rules. On the basis of this example, too, it is clear that employing the typology is not as straightforward as one might expect.

In many respects, the study also shows that the problem of misclassification is usually related to other issues. Categories like VFR and IFR are not superficial conceptual distinctions, but they contain many substantive rules that can appear problematic or non-problematic from the perspective of new technology. The same applies to operational categories. It might not be questionable to classify certain drone operation as commercial air transport, but the existing rules following from such a classification can bring about various issues. The common problem with misclassification is, indeed, that it results in over- or under-inclusiveness rather than a mere mischaracterization of facts.

6.4.2. Combining Approaches

The case of drones examined in the study equally supports constructing a new typology of the legislative approaches to the problems created by sociotechnical change. This is the second half of the complete model. The overall shortcoming of the typology is that it does not aim at developing the most optimal—in terms of adaptiveness, participation, efficiency, transparency, or timeliness—way of regulating UAS or any sociotechnical change for that matter. Its purpose is merely to map out the different ways in which legislation can respond to new technology, which is inevitably a limited perspective.

Another problem is that the differences between the approaches are not always as distinguishable as it may appear: it can be difficult to categorize a particular legislative choice. This applies to all the approaches. On one hand, for example, ICAO has displayed passivity in relation to Article 8 of the Chicago Convention. Using the provision as a starting point is passive in the sense that its creation was not related to the current influx of unmanned aircraft systems. Given the wording of the provision, it is obvious that the state parties to the treaty could not foresee the new drone technology either. It is not a reaction to increasing unmanned aviation during the 21st century. From another viewpoint, though, the use of Article 8 is a case of replication. This is so because ICAO has taken explicit steps to affirm that the provision applies to current drones, too. The inherited rule that the international flying of an "aircraft capable of being flown without a pilot" requires authorization from the overflown state is transferred into the context of modern drones.

As one might expect, some legislative choices tread the line between replication and emulation. One case of this is EU's certified category of operations. The default approach in the category is replication. Rules on airworthiness, operations, rules of the air, and so forth, are to be applied as they are to drones in the category. To the extent new rules have been enacted, they merely state the given dictum. Yet this approach is hardly enough, as transferring the rules will necessitate some adjustments in the rules that are not perfectly receptive to unmanned aviation. The certified category hence ultimately becomes a case of emulation. The traditional rules will be suited to drones through the creation of provisions that transfer the substance to apply to the new technology, and replication appears merely as a general starting point. Since ICAO's legislative effort focuses on a similar level of operations (though the organization does not refer to the categories), the international rules so far also mix replication and emulation.

Sometimes it is questionable whether certain legislative action should be categorized as involving emulation or alternative rules. ICAO's RPAS operator certificate is a viable example of this. Above, I characterized it as a case of emulation. There are good reasons to do so because the concept essentially transfers the concept of air operator certificate to unmanned aviation. Still, when examined in detail, the concept also introduces a few wholly alternative standards that are based on the unique features of UAS. The certified category of operations is also relevant in this delimitation. Most notably, the certification specifications for drones with airworthiness certification can include alternative rules. This is so when the CSs do not borrow from existing specifications but instead set forth requirements that are completely unique in their substance. Some such specifications are to be expected with regard to, among other things, the C2 link, which is not used in manned aviation.

Transformation is clearly at odds with both replication and emulation. If the scope of an old rule is extended to cover an aspect of new technology, no transformation occurs. The same can be said of a situation in which the core substance of such a rule is transferred, with some modifications, to cover new technology. With regard to individual rules, then, there is no overlap in the approaches. Yet when transformation occurs on the level of the whole system, the scope of some old individual rules may simply be extended as a part of the overall new legal framework. In such cases, it is possible to view the overall change as a transformation that, regardless, contains cases of replication and emulation. One must thus notice when the overall approach is of some type and when the approach of an individual rule is of another type. This could be viewed as weakening the descriptive power of the typology.

The relationship between transformation and alternative rules is also rather clear-cut. The former involves changing old rules or the system overall, while the latter involves the enactment of additional rules to the system. From a temporal perspective, though, the case of drones shows that some legislative developments can mix the approaches. The U-space is the best and perhaps the only example thereof. In its current form, the U-space developed, tested, and employed by various service providers across Europe is simply an addition to the current system of air traffic management. The regulations proposed thus far also testify to its alternative character. Yet the concept has the potential to ultimately transform our entire approach to air traffic control and management. This goes to show that transformation should not mainly be understood as involving just one overhaul. Instead, smaller changes can take place here and there in the legislative framework, slowly transforming the system into a different one.

6.4.3. Optimizing Legislation?

As acknowledged, the model of legislation and sociotechnical change developed here does not aim at developing the most optimal way of identifying legal issues and providing solutions thereto. Its primary purpose is to establish some systematic elements to discuss the given matters. The value of doing so can naturally be questioned, but the study insists that developing these kinds of theoretical vocabularies is a worthwhile exercise—even if the benefits thereof do not manifest themselves in an obvious and instant manner. They can be employed in broader discussions about the flexibility, timing, incentivization, participation, and neutrality of regulation.

Regardless, the model may aid in drawing normative implications also concerning the most optimal manner of legislation. At the very least, it shows that sweeping arguments about using or not using existing rules, generating new rules, or changing rules, are generally mistaken. In order to deal with new technology and its use, a divergent range of legislative measures can and should be adopted. Drawing on drones as an example, it is clear that no single approach is sufficient, and that approaching particular sociotechnical change as a singular entity is mistaken, too. In any change, there are aspects that can be ignored, that can be handled using existing rules, that require different rules, and that can necessitate purging existing laws or executing a complete makeover.

On a more particular level, the study does not attempt to form definite pathways from certain issues to certain legislative solutions. Doing so would simply risk ignoring the broad range of choices that legislators have in relation to the issues. Still, the model offers a basis for such an analysis. For instance, misclassification clearly cannot be solved through replication because the existing rules demonstrably fail at properly applying to some aspect of the sociotechnical change. Meanwhile, the optimal response to under-inclusiveness appears either replication or emulation, since the problem is the narrow scope of the existing rules. Irrelevance and injustice, on the other hand, obviously suggest transformation, given that they signify faults in present rules. Over-inclusiveness and ineffectiveness can either spark alternative rules or transformation, depending on the extent of the sociotechnical change, but they cannot be solved by replicating old rules. The construction of pathways between the two sides of the model thus remains a theoretical opportunity for future studies.

The model also compiles some of the benefits and disadvantages of different legislative approaches. Passivity allows the legislator to observe whether a sociotechnical change is really occurring or worth legislating in the first place, but it can be untenable in the long run. Replication and emulation require less effort, can sometimes produce justified uniformity, and make less assumptions about future changes. The choice between these two is determined by whether modifying the rules is necessary. Replication merely extends the scope of familiar rules to new technology; emulation requires transposing the rules to meet the characteristics of the new technology. The downside is, though, that using old rules perpetuates their disadvantages and perhaps even questionable values. It may also hinder the development of more suitable legislative solutions in the long run.

The task of drafting alternative rules is more burdensome, since it compels the legislator to use their imagination and work closely with the developing technology itself. This close relationship can simultaneously risk law being too closely influenced by technological viewpoints. However, in many cases creating new concepts, standards, and procedures is necessary to appropriately deal with the sociotechnical change. The most difficult approach is transformation, since rather than building on existing rules it seeks to either repeal them or change them. Transformation might indeed only be appropriate when new technology challenges the whole character of a particular system.

One aspect largely ignored by the present model is that legislative approaches themselves may create new kinds of issues that are encapsulated by the model. As the issues identified by the model are inextricably linked to the idea of existing law, the issues caused by the new rules, which do fall within the ambit of the same sociotechnical change, can be different. The character of the present study does not, however, allow extending the model further into such issues. The types of issues caused by the new rules on drones, for instance, cannot be fully explored until there is an attempt at their application. Such exploration can of course take place in the future, as the more or less problematic nature of the new rules is exposed through application. In its current form the model simply assumes that the issues will be similar: in other words, the model is cyclical.

6.4.4. Past and Future Drone Law

The present study was written between the years 2016 and 2020 at a time when some of the earliest safety and security rules on modern civil UAS were being developed and enacted at the international and European level. The study provides a broad outlook, grasping many related topics, so it is not an encyclopedic one. Many rules falling within the ambit of aviation safety and security have been left uncited, as the purpose has been to highlight key aspects at the expense of completeness. Indeed, presenting every single detail of safety law on manned and unmanned aircraft would have been both counterproductive and vain, especially in relation to drones. As such, the study represents an abbreviated, generalized take on a legal framework that is still in many respects under development.

The main purpose of the present study has not been to issue precise legislative recommendations that would alter the present framework. From the viewpoint of *de lege ferenda*, the discussion above regardless points to several aspects in which the present framework—including the new drone-specific rules—should be developed. Airworthiness standards for the command and control link, the remote pilot station, and the means by which drones will communicate vis-à-vis each other and other aircraft are still required to facilitate safe integration, and the whole certified category in the EU remains largely a mystery. The specific category is thus far mostly a blueprint that must be put into action and supplemented with requirements on, for instance, pilot training. The U-space is only in its early stages, requiring the EU to, *inter alia*, decide on the competition and security aspects of providing services therein. This study calls for the legislators to continue their efforts in solving the given problems in a manner that is sensitive to the present and future sociotechnical situation.

Making generalizations about the past and predicting the future of aviation industry, indeed any industry, is difficult due to the persistency, unpredictability, and speed of all sociotechnical change. The present study has sought to look both into the past and the future in a rather moderate manner. The arguments are tied to concrete facts and legal documents, and there is an attempt to preface them with caveats: sociotechnical change is not unique to this moment and this case, and the changes and issues are diverse rather than monolithic. In more concrete terms, there is no singular type of manned aviation nor unmanned aviation. At the same time, the study argues that there are ways in which the present change is unique, and that there are significant differences between manned and unmanned aviation. The technology we do not have at the time of writing this is a possibility: sometimes a likely one, sometimes less so.

In order to close the circle, we must consider that

> [a]ll interpretation, all psychology, all attempts to make things comprehensible, require the medium of theories, mythologies and lies; and a self-respecting author should not omit, at the close of an exposition, to dissipate these lies so far as may be in his power.[669]

Here, this refers to the possibility that the change dealt with in this study is but the beginning of a greater coalescence in mobility, or but the death throes of a system misclassifying such coalescence. I mean by this that the idea of sociotechnical change should not only be understood as the development of better UAS or the increase in unmanned civil aviation. Presently, we are concerned with a division between cases in which the pilot is on board the aircraft or on the ground: this was the very starting point of this study. But, as the overall automation in aviation increases, we may no longer be able to meaningfully uphold such a distinction. Whatever concerns we have of legislation unjustly favoring one or the other might come to pass.

Furthermore, sociotechnical change is not limited to the context of aviation at all but includes a wide range of forces acting in relation to one another. It encapsulates all mobility, as ultimately the most important purpose of aviation—whatever one may think of it—is to move things around. At the same time, sociotechnical change encapsulates all technology, as ultimately the purpose of technology is to extend human capabilities. There is hence change and Change. The problem, however, is that we can barely see the former, and the latter appears as almost pure fiction: they are almost untouchable. This brings a meaning to exercises, such as the present study, which are irrevocably limited but concretely tied to a particular time and place.

669 Hesse 1927/1969, p. 65.

References

A Note on Formalities

This dissertation chiefly follows the format commonly utilized in Finnish legal dissertations. Sources are chiefly referred to using footnotes, although the provisions of documents like treaties are at times referred to in the text. Bibliographical sources are referred to with the surname of the author and the year of the publication. If an edited volume is referred to as a whole, the volume is referred to with the surname of the editor(s). If the original version of the publication is utilized, no reference is made to further editions. However, if a revised, republished, or translated edition has been utilized, both the original year of publication and the year of the new edition are mentioned.

Sources other than those attributable to authors are always referred to with the full name of the document in italics. If a particular source is utilized often, a namesake is given to the source in parentheses after the full name. When a number of sources are referred to, the footnote lists them in alphabetical order, typically beginning with legal documents. Furthermore, in cases where a single primary source is supported by others, the footnote first lists the primary source, followed by the others after a citation signal "see also".

Sources referred to are listed below in alphabetical order pursuant to the surname of the author (when attributable to one or several authors) or the name of the document. Documents of the European Union are listed alphabetically by category but documents within each category, such as Commission Regulations, are listed in an ascending chronological order. A hyperlink for the source is provided when the source is only available online. All hyperlinks were last accessed on 18 September 2020.

Publications Attributable to Authors

Aarnio, Aulis (2011) *Essays on the Doctrinal Study of Law*. Dordrecht et al.: Springer.

Abbott, Kenneth W. (1992) *Elements of a Joint Discipline*. In *American Society of International Law Proceedings*, Vol. 86, pp. 167–172. Washington, DC: The American Society of International Law.

(2011) *An International Framework Agreement on Scientific and Technological Innovation and Regulation*. In Marchant, Gary E. – Allenby, Braden R. – Herkert, Joseph R. (eds.) *The Growing Gap Between Emerging Technologies and Legal-Ethical Oversight: The Pacing Problem*, pp. 127–156. Dordrecht et al.: Springer.

(2013) *Introduction: the challenges of oversight for emerging technologies*. In Marchant, Gary E. – Abbott, Kenneth W. – Allenby, Braden (eds.) *Innovative Governance Models for Emerging Technologies*, pp. 1–16. Cheltenham, UK & Northampton, MA: Edward Elgar.

Abeyratne, Ruwantissa (2014) *Convention on International Civil Aviation: A Commentary*. Heidelberg et al.: Springer.

(2016) *Remotely Piloted Aircraft Systems: Some Unexplored Issues*. In *Air & Space Law*, Vol. 41, No. 3, pp. 289–303. Alphen aan den Rijn: Kluwer Law International.

Altawy Riham – Youssef Amr M. (2016) *Security, Privacy, and Safety Aspects of Civilian Drones: A Survey*. In *ACM Transactions on Cyber-Physical Systems*, Vol. 1, No. 2, Article No. 7. New York, NY: Association for Computing Machinery.

Alter, Karen J. (2002) *1 A political science perspective*. In *Forum section: Law, Political Science and EU Legal Studies: An Interdisciplinary Project?* In *European Union Politics*, Vol. 3, No. 1, pp. 113–136. London, UK et al.: SAGE Publications.

Annas, George J. – Glantz, Leonard H. – Roche, Patricia A. (1995) *Drafting the Genetic Privacy Act: Science, Policy and Practical Considerations*. In *Journal of Law, Medicine and Ethics*, Vol. 23, No. 4, pp. 360–366. Thousand Oaks, CA: SAGE Publications and American Society of Law, Medicine and Ethics.

Archambault, Laurent – Mâzouz, Alicia (2015) *L'envol des drones civils : Appréhension par le droit français d'une pratique émergente*. In *Annals of Air and Space Law*, Vol. 40. Montreal: Institute and Centre of Air and Space Law, Faculty of Law, McGill University.

Armitage, Michael Sir (1988) *Unmanned Aircraft*. Brassey's Air Power: Aircraft, Weapon Systems and Technology Series, Vol. 3. London et al., UK: Brassey's Defence Publishers.

Armstrong, Joe E. – Harman, Willis W. (1980) *Strategies for Conducting Technology Assessments*. Boulder, CO: Westview Press.

Ashford, Nicholas A. – Ayers, Christine – Stone, Robert F. (1985) *Using Regulation to Change the Market for Innovation*. In *Harvard Environmental Law Review*, Vol. 9, No. 2, pp. 419–466. Cambridge, MA: Harvard University.

Askland, Andrew (2011) *Introduction: Why Law and Ethics Need to Keep Pace with Emerging Technologies*. In Marchant, Gary E. – Allenby, Braden R. – Herkert, Joseph R. (eds.) *The Growing Gap Between Emerging Technologies and Legal-Ethical Oversight: The Pacing Problem*, pp. xiii–xxvii. Dordrecht et al.: Springer.

Asselt, Marjolein van – Vos, Ellen – Fox, Tessa (2010) *Regulating Technologies and the Uncertainty Paradox*. In Goodwin, Morag – Koops, Bert-Jaap – Leenes, Ronald (eds.) *Dimensions of Technology Regulation: Conference proceedings of TILTing Perspectives on Regulating Technologies*, pp. 259–284. Nijmegen: Wolf Legal Publishers.

Austin, John (1832/1995) *The province of jurisprudence determined*. Edited by Rumble, Wilfrid E. Cambridge, UK: Cambridge University Press. Originally London, UK: John Murray.

Baldwin, Robert – Cave, Martin – Lodge, Martin (2012) *Understanding Regulation: Theory, Strategy, and Practice*, 2nd edition. Oxford, UK: Oxford University Press.

Barlow, John Perry (1994) *The Economy of Ideas: A framework for rethinking patents and copyrights in the Digital Age*. In *Wired*, No. 2.03. San Francisco, CA: Wired Ventures.

Bellows, Brandon (2013) *Floating Toward a Sky Near You: Unmanned Aircraft Systems and the Implications of the FAA Modernization and Reform Act of 2012*. In *Journal of Air Law and Commerce*, Vol. 78, No. 3, pp. 585–615. Dallas, TX: Southern Methodist University School of Law.

Bennett Moses, Lyria (2003) *Adapting the Law to Technological Change: A Comparison of Common Law and Legislation*. In *University of New South Wales Law Journal*, Vol. 26, No. 2, pp. 394–417. Sydney: University of New South Wales Law School.

(2005) *Understanding Legal Responses to Technological Change: The Example of In Vitro Fertilization*. In *Minnesota Journal of Law, Science & Technology*, Vol. 6, No. 2, pp. 505–618. Minneapolis, MN: University of Minnesota Law School.

(2007a) *Why Have a Theory of Law and Technological Change?* In *Minnesota Journal of Law, Science & Technology*, Vol. 8, No. 2, pp. 589–606. Minneapolis, MN: University of Minnesota Law School.

(2007b) *Recurring Dilemmas: The Law's Race to Keep Up with Technological Change*. In *University of Illinois Journal of Law, Technology & Policy*, Vol. 2007, No. 2, pp. 239–285. Champaign, IL: University of Illinois College of Law.

(2011a) *Agents of Change: How the Law 'Copes' with Technological Change*. In *Griffith Law Review*, Vol. 20, No. 4, pp. 763–794. Brisbane: Socio-Legal Research Centre, Griffith University.

(2011b) *Sui Generis Rules*. In Marchant, Gary E. – Allenby, Braden R. – Herkert, Joseph R. (eds.) *The Growing Gap Between Emerging Technologies and Legal-Ethical Oversight: The Pacing Problem*, pp. 77–94. Dordrecht et al.: Springer.

(2013a) *Bridging distances in approach: Sharing ideas about technology regulation*. In Leenes, Ronald E. – Kosta, Eleni (eds.) *Bridging Distances in Technology and Regulation*, Version of record, pp. 37–51. Oisterwijk: Wolf Legal Publishers.

(2013b) *How to Think about Law, Regulation and Technology: Problems with 'Technology' as a Regulatory Target*. In *Law, Innovation and Technology*, Vol. 5, No. 1, pp. 1–20. Abingdon-on-Thames, UK: Taylor & Francis.

(2017) *Regulating in the Face of Sociotechnical Change*. In Brownsword, Roger – Scotford, Eloise – Yeung, Karen (eds.) *The Oxford Handbook of Law, Regulation, and Technology*, pp. 573–596. Oxford, UK: Oxford University Press.

Bernstein, Gaia (2002) *The Socio-Legal Acceptance of New Technologies: A Close Look at Artificial Insemination*. In *Washington Law Review*, Vol. 77, No. 4, pp. 1035–1120. Seattle, WA: University of Washington School of Law.

Bijker, Wiebe E. (1995) *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change*. Cambridge, MA & London, UK: The MIT Press.

Bijker, Wiebe E. – Hughes, Thomas P. – Pinch, Trevor (1987/2012) *General Introduction*. In Bijker, Wiebe E. – Hughes, Thomas P. – Pinch, Trevor (eds.) *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, Anniversary Edition, pp. xxxix–xliv. Cambridge, MA: The MIT Press.

Bijker, Wiebe E. – Law, John (1992) *General Introduction*. In Bijker, Wiebe E. – Law, John (eds.) *Shaping Technology/Building Society: Studies in Sociotechnical Change*, pp. 1–14. Cambridge, MA: MIT Press.

Black, Julia (2001) *Decentring Regulation: Understanding the Role of Regulation and Self-Regulation in a 'Post-Regulatory' World*. In *Current Legal Problems*, Vol. 54, No. 1, pp. 103–146. Oxford, UK: Oxford University Press.

(2002) *Critical Reflections on Regulation*. In *Australian Journal of Legal Philosophy*, Vol. 27, No. 1, pp. 1–35. Canberra: Australian Society of Legal Philosophy.

(2008) *Forms and paradoxes of principles-based regulation*. In *Capital Markets Law Journal*, Vol. 3, No. 4, pp. 425–457. Oxford, UK: Oxford University Press.

Bonfield, Arthur E. (1964) *The Abrogation of Penal Statutes by Nonenforcement*. In *Iowa Law Review*, Vol. 49, No. 2, pp. 389–440. Iowa City, IA: University of Iowa College of Law.

Bowden, Claude Evelyn (1946) *The History and Technical Development of Model Aircraft*. Leicester, UK: The Drysdale Press for The Harborough Publishing Company.

Bower, Joseph L. – Christensen, Clayton M. (1995) *Disruptive Technologies: Catching the Wave*. In *Harvard Business Review*, Vol. 73, No. 1 (January–February), pp. 43–53. Brighton, MA: Harvard Business Publishing.

Boyle, James (1992) *Introduction*. In Boyle, James (ed.) *Critical Legal Studies*, pp. xiii–liii. New York, NY: New York University Press.

Brenner, Susan W. (2007) *Law in an Era of "Smart" Technology*. New York, NY: Oxford University Press.

Brownsword, Roger (2008) *Rights, Regulation, and the Technological Revolution*. Oxford, UK: Oxford University Press.

(2017) *Law, Liberty, and Technology*. In Brownsword, Roger – Scotford, Eloise – Yeung, Karen (eds.) *The Oxford Handbook of Law, Regulation, and Technology*, pp. 41–68. Oxford, UK: Oxford University Press.

Brownsword, Roger – Scotford, Eloise – Yeung, Karen (2017) *Law, Regulation, and Technology: The Field, Frame, and Focal Questions*. In Brownsword, Roger – Scotford, Eloise – Yeung, Karen (eds.) *The Oxford Handbook of Law, Regulation, and Technology*, pp. 3–38. Oxford, UK: Oxford University Press.

Brownsword, Roger – Somsen, Han (2009) *Law, Innovation and Technology: Before We Fast Forward—A Forum for Debate*. In *Law, Innovation and Technology*, Vol. 1, No. 1, pp. 1–73. Abingdon-on-Thames, UK: Taylor & Francis.

Buehler, Nathan (2018) *Economics of Owning a Small Plane*. Investopedia. https://bit.ly/2z9DTm5.

Burk, Dan L. – Lemley, Mark A. (2003) *Policy Levers in Patent Law*. In *Virginia Law Review*, Vol. 89, No. 7, pp. 1575–1696. Charlottesville, VA: The Virginia Law Review Association.

Calabresi, Guido (1982) *A Common Law for the Age of Statutes*. Cambridge, MA & London, UK: Harvard University Press.

Carolan, Eoin (2009) *The New Separation of Powers: A Theory for the Modern State*. Oxford, UK & New York, NY: Oxford University Press.

Carroll, Michael W. (2006) *The Problem of Uniformity Cost in Intellectual Property Law*. In *American University Law Review*, Vol. 55, No. 4, pp. 845–900. Washington, DC: American University Washington College of Law.

Carta, Matteo – Senatore, Costantino – Tomasello, Filippo (2018) *U-Space is Coming*. In *The Aviation & Space Journal*, Vol. 17, No. 2, pp. 16–29. Bologna: University of Bologna.

Carter, Ruth B. – Marchant, Gary E. (2011) *Principles-Based Regulation and Emerging Technology*. In Marchant, Gary E. – Allenby, Braden R. – Herkert, Joseph R. (eds.) *The Growing Gap Between Emerging Technologies and Legal-Ethical Oversight: The Pacing Problem*, pp. 157–166. Dordrecht et al.: Springer.

Castillo-Ruiz (2015) *Property and Privacy Issues Arising from the Integration of Civil and Commercial Drones into the Domestic Airspace of the United States*. In *Annals of Air and Space Law*, Vol. 40. Montreal: Institute and Centre of Air and Space Law, Faculty of Law, McGill University.

Cavers, David F. (1967) *Law and Science: Some Points of Confrontation*. In Jones, Harry W. (ed.) *Law and the Social Role of Science*, pp. 5–15. New York, NY: The Rockefeller University Press.

Chase-Dunn, Christopher – Lerro, Bruce (2014/2016) *Social Change: Globalization from the Stone Age to the Present*. Abingdon, UK & New York, NY: Routledge. Originally Boulder, CO: Paradigm Publishers.

Christen, Markus – Guillaume, Michel – Jablonowski, Maximilian – Lenhart, Peter – Moll, Kurt (2018) *Zivile Drohnen – Herausforderungen und Perspektiven*. Zürich: vdf Hochschulverlag AG an der ETH Zürich.

Christensen, Clayton M. (1997/2000) *The Innovator's Dilemma*. New York, NY: HarperBusiness.

Cloatre, Emilie – Pickersgill, Martyn (2015) *Introduction*. In Cloatre, Emilie – Pickersgill, Martyn (eds.) *Knowledge, Technology and Law*, pp. 1–14. Abingdon, UK & New York, NY: Routledge.

Cockfield, Arthur J. (2004) *Towards a Law and Technology Theory*. In *Manitoba Law Journal*, Vol. 30, No. 3, pp. 383–415. Winnipeg, MB: University of Manitoba.

Cockfield, Arthur J. – Pridmore, Jason (2007) *A Synthetic Theory of Law and Technology*. In *Minnesota Journal of law, Science & Technology*, Vol. 8, No. 2, pp. 475–513. Minneapolis, MN: University of Minnesota Law School.

Coleman, Jules L. (1982) *Negative and Positive Positivism*. In *The Journal of Legal Studies*, Vol. 11, No. 1, pp. 139–164. Chicago, IL: The University of Chicago Press for The University of Chicago Law School.

Collingridge, David (1980) *The Social Control of Technology*. London, UK: Frances Pinter.

Coluccia, Angelo – Parisi, Gianluca – Fascista, Alessio (2020) *Detection and Classification of Multirotor Drones in Radar Sensor Networks: A Review*. In *Sensors*, Vol. 20, No. 15. Basel: MDPI.

Comte, Auguste (1853) *The Positive Philosophy of Auguste Comte*. Translated by Martineau, Harriet. New York, NY: D. Appleton and Co.

Cooper, John C. (1951/1968) *Air Law—A Field for International Thinking*. In Vlasic, Ivan A. (ed.) *Explorations in Aerospace Law: selected essays by John Cobb Cooper*, pp. 2–15. Montreal: McGill University Press. Originally in *Transport and Communications Review*, Vol. 4, No. 4, pp. 1–7. New York, NY: United Nations.

Cortez, Nathan (2014) *Regulating Disruptive Innovation*. In *Berkeley Technology Law Journal*, Vol. 29, No. 1, pp. 175–228. Berkeley, CA: University of California, Berkeley School of Law.

Custers, Bart (2016, ed.) *The Future of Drone Use: Opportunities and Threats from Ethical and Legal Perspectives*. The Hague: TMC Asser.

Dagan, Hanoch (2018) *The Real Legacy of American Legal Realism*. In *Oxford Journal of Legal Studies*, Vol. 38, No. 1, pp. 123–146. Oxford, UK: Oxford University Press.

Decker, Michael (2001, ed.) *Interdisciplinarity in Technology Assessment: Implementation and its Chances and Limits*. Berlin et al.: Springer.

Decker, Michael – Ladikas, Miltos (2004, eds.) *Bridges between Science, Society and Policy: Technology Assessment – Methods and Impacts*. Berlin et al.: Springer.

Deflem, Mathieu (2008) *Sociology of Law: Visions of a Scholarly Tradition*. Cambridge, UK: Cambridge University Press.

Desmond, Kevin (2018) *Electric Airplanes and Drones: A History*. Jefferson, NC: McFarland & Company.

Diederiks-Verschoor, Isabella Henrietta Philepina (1983) *An Introduction to Air Law*. Deventer: Kluwer Law and Taxation.

Diver, Colin S. (1983) *The Optimal Precision of Administrative Rules*. In *Yale Law Journal*, Vol. 93, No. 1, pp. 65–109. New Haven, CT: The Yale Law Journal Company.
Dizon, Michael Anthony C. (2013) *Rules of a networked society: Here, there and everywhere*. In Leenes, Ronald E. – Kosta, Eleni (eds.) *Bridging Distances in Technology and Regulation*, Version of record, pp. 83–102. Oisterwijk: Wolf Legal Publishers.
Doganis, Rigas (1985/2019) *Flying Off Course: Airline Economics and Marketing*, 5th edition. Abingdon-on-Thames, UK: Routledge. Originally *Flying Off Course: The Economics of International Airlines*. London, UK: Allen & Unwin.
Drahos, Peter (1985) *Law, Science, and Reproductive Technology*. In *Bulletin of the Australian Society of Legal Philosophy*, Vol. 9, No. 4, pp. 270–285. Sydney: University of Sydney.
(2017, ed.) *Regulatory Theory: Foundations and Applications*. Acton: Australian National University Press.
Dulo, Donna A. (2016) *Unmanned Aircraft in the National Airspace: Critical Issues, Technology, and the Law*. Chicago, IL: American Bar Association.
Dunkerley, David – Glasner, Peter (1998) *Empowering the public? Citizens' juries and the new genetic technologies*. In *Critical Public Health*, Vol. 8, No. 3, pp. 181–192. Abingdon-on-Thames, UK: Routledge.
Dunlop, John (1976) *The Limits of Legal Compulsion*. In *Labor Low Journal*, Vol. 13, No. 2, pp. 65–74. South Hackensack, NJ: Fred B. Rothman & Co.
Dworkin, Ronald (1967) *The Model of Rules*. In *University of Chicago Law Review*, Vol. 35, No. 1, pp. 14–46. Chicago, IL: The University of Chicago Law School.
(1986) *Law's Empire*. Cambridge, MA: The Belknap Press of Harvard University Press.
Ehrlich, Isaac – Posner, Richard A. (1974) *An Economic Analysis of Legal Rulemaking*. In *Journal of Legal Studies*, Vol. 3, No. 1, pp. 257–286. Chicago, IL: The University of Chicago press.
Elias, Bartholomew (2010) *Airport and Aviation Security: U.S. Policy and Strategy in the Age of Global Terrorism*. Boca Raton, FL: Taylor & Francis.
Ellul, Jacques (1964) *The Technological Society*. Translated by Wilkinson, John. New York, NY: Vintage Books.
Ely, James W. (2001) *Railroads and American Law*. Lawrence, KS: University Press of Kansas.
Evera, Stephen Van (1997) *Guide to Methods for Students of Political Science*. Ithaca, NY: Cornell University Press.
Feenberg, Andrew (1999) *Questioning Technology*. London, UK: Routledge.
(2002) *Transforming Technology: A Critical Theory Revisited*. New York, NY: Oxford University Press.
Fiallos Pazmiño, Luis Fernando (2019) *Legal Perspectives on the Cross-border Operations of Unmanned Aircraft Systems*, proefschrift. Bodegraven: AlphaZet prepress.
Flear, Mark L. – Pfister, Thomas (2015) *Contingent participation: Imaginaries of sustainable technoscientific innovation in the European Union*. In Cloatre, Emilie – Pickersgill, Martyn (eds.) *Knowledge, Technology and Law*, pp. 33–49. Abingdon, UK & New York, NY: Routledge.
Florio, Filippo De (2016) *Airworthiness: An Introduction to Aircraft Certification and Operations*, 3rd edition. Oxford, UK: Butterworth-Heinemann.
Form, William – Wilterdink, Nico (undated) *Social Change*. In *Encyclopaedia Britannica*. https://www.britannica.com/topic/social-change.
Fox, Sarah Jane (2017) *The Rise of the Drones: Framework and Governance – Why Risk It!* In *Journal of Air Law and Commerce*, Vol. 82, No. 4, pp. 683–716. Dallas, TX: Southern Methodist University School of Law.
Friedman, Aryeh S. (1986) *Law and the Innovative Process: Preliminary Reflections*. In *Columbia Business Law Review*, Vol. 1986, No. 1, pp. 1–48. New York, NY: Columbia Law School.

Friedman, David (2001) *Does Technology Require New Law?* In *Harvard Journal of Law & Public Policy*, Vol. 25, No. 1, pp. 71–85. Cambridge, MA: Harvard Society for Law & Public Policy.

Galluzzi, David (2000) *The Doping Crisis in International Athletic Competition: Lessons from the Chinese Doping Scandal in Women's Swimming*. In *Seton Hall Journal of Sport Law*, Vol. 10, No. 1, pp. 65–110. Newark, NJ: Seton Hall Law School.

Gaudet, Lyn M. – Marchant, Gary E. (2011) *Administrative Law Tools for More Adaptive and Responsive Regulation*. In Marchant, Gary E. – Allenby, Braden R. – Herkert, Joseph R. (eds.) *The Growing Gap Between Emerging Technologies and Legal-Ethical Oversight: The Pacing Problem*, pp. 167–182. Dordrecht et al.: Springer.

George, Alexander L. – Bennett, Andrew (2005) *Case Studies and Theory Development in the Social Sciences*. Cambridge, MA & London, UK: MIT Press.

Gerring, John (2007) *Case Study Research: Principles and Practices*. Cambridge, UK: Cambridge University Press.

Gersen, Jacob E. (2007) *Temporary legislation*. In *University of Chicago Law Review*, Vol. 74, No. 1, pp. 247–297. Chicago, IL: University of Chicago Law School.

Giemulla, Elmar (2007) *Unbemannte Luftfahrzeugsysteme – Probleme ihrer Einfügung in das zivile und militärische Luftrecht*. In *Zeitschrift für Luft- und Weltraumrecht*, Vol. 56, No. 2, pp. 195–210. Cologne: Institut für Luft- und Weltraumrecht der Universität zu Köln.

Giemulla, Elmar – Schnydel, Heiko van – Friedl, Achim (2017) *Gewerblicher und privater Einsatz von Drohnen: Regelung des Betriebs von unbemannten Fluggeräten*. Cologne: Hermann Luchterhand Verlag.

Gilbertson, Scott (2015) *Why It's Never Been Easier to Fly a Drone*, https://bit.ly/2ViVhgW.

Gillispie, Charles Coulston (1983) *The Montgolfier Brothers and the Invention of Aviation 1783-1784*. Princeton, NJ: Princeton University Press.

Gilmore, Grant (1967) *On Statutory Obsolescence*. In *University of Colorado Law Review*, Vol. 39, No. 4, pp. 461–477. Boulder, C

Grant, R. G. (2017) *Flight: The Complete History of Aviation*, updated edition. New York, New York: DK Publishing.

Green, Leslie (2019) *Positivism, Realism, and Sources of Law*. Oxford Legal Studies Research Paper No. 53/2019. https://ssrn.com/abstract=3443743.

Greenberg, Brad A. (2016) *Rethinking Technology Neutrality*. In *Minnesota Law Review*, Vol. 100, No. 4, pp. 1495–1562. Minneapolis, MN: University of Minnesota Law School.

Grin, John – Graaf, Henk van de – Hoppe, Rob (1997) *Technology Assessment through Interaction: A guide*. The Hague: SDU.

Groh, Benedikt A. (2019) *Entwicklung eines Rechtsrahmens zum Betrieb ziviler unbemannter Fluggeräte: Eine rechtsvergleichende Analyse des bestehenden nationalen Rechtsrahmens mit dem Rechtsrahmen der Vereinigten Staaten von Amerika*. Munich: Herbert Utz Verlag.

Haanappel, Peter P. C. (2003) *The Law and Policy of Air Space and Outer Space*. The Hague: Kluwer Law International.

Haferkamp, Hans-Peter (2004) *Georg Friedrich Puchta und die "Begriffsjurisprudenz"*. Frankfurt am Main: Klostermann.

Hart, Henry M. Jr. – Sacks, Albert M. (1958/1994) *The Legal Process: Basic Problems in the Making and Application of Law*, tentative edition. Edited by Eskridge, William N. Jr. – Frickey, Philip P. New York, NY: Foundation Press.

Hart, Herbert L. A. (1961/2012) *The Concept of Law*. Oxford, UK: Oxford University Press. Originally Oxford, UK: Clarendon Press.

Harter, Philip J. (1982) *Negotiated Regulations: A Cure for Malaise*. In *Georgetown law Journal*, Vol. 71, No. 1, pp. 1–118. Washington, DC: Georgetown Law Journal Association.

Havel, Brian F. – Mulligan, John Q. (2015) *Unmanned Aircraft Systems: A Challenge to Global Regulators*. In *DePaul Law Review,* Vol. 65, No. 1, pp. 107–121. Chicago, IL: DePaul College of Law.

Havel, Brian F. – Sanchez, Gabriel S. (2014) *The Principles and Practice of International Aviation Law*. Cambridge, UK: Cambridge University Press.

Hawkes, Daniel (2007) *Eurocae WG-73 on Unmanned Aircraft Systems*. In Van Blyenburgh, Peter (ed.) *UAS – Unmanned Aircraft Systems: The Global Perspective 2007/2008*, pp. 36–37. Paris: Blyenburgh & Co.

Heidegger, Martin (1954/1977) *The Question Concerning Technology*. In *The Question Concerning Technology and Other Essays*, pp. 1–35. Translated by Lovitt, William. New York, NY & London, UK: Garland Publishing. Originally *Die Frage nach der Technik*. In *Vorträge und Aufsätze*, pp. 9–40. Pfüllingen: Günther Neske.

Heilbroner, Robert L. (1967) *Do Machines Make History?* In *Technology and Culture*, Vol. 8, No. 3, pp. 335–345. Baltimore, MD: The Johns Hopkins University Press.

Hesse, Hermann (1927/1969) *Steppenwolf*. Translated by Creighton, Basil; updated by Mileck, Joseph, with some suggestion by Frenz, Horst. New York, NY: Bantam Books. Originally *Der Steppenwolf*. Berlin: S. Fischer Verlag.

Hildebrandt, Mireille (2009) *Chapter 23 – Technology and the End of Law*. In Claes, Erik – Devroe, Wouter – Keirsblick, Bert (eds.) *Facing the Limits of the Law*, pp. 443–464. Berlin & Heidelberg: Springer.

Hildebrandt, Mireille – Tielemans, Laura (2013) *Data Protection by Design and Technology Neutral Law*. In *Computer Law & Security Review*, Vol. 29, No. 5, pp. 509–521. Amsterdam: Elsevier.

Hodgkinson, David – Johnston, Rebecca (2018) *Aviation Law and Drones: Unmanned Aircraft and the Future of Aviation*. Abingdon, UK: Routledge.

Hoecke, Mark Van (2011) *Legal Doctrine: Which Method(s) for What Kind of Discipline?* In Hoecke, Mark Van (ed.) *Methodologies of Legal Research: Which Kind of Method for What Kind of Discipline?*, pp. 1–18. Oxford, UK & Portland, OR: Hart Publishing.

Hoenkamp, Robin A. – Vugt, Adrienne J.C. de Moor – Huitema, George B. (2013) *Law and standards: Safeguarding societal interests in smart grids*. In Leenes, Ronald E. – Kosta, Eleni (eds.) *Bridging Distances in Technology and Regulation*, Version of record, pp. 103–122. Oisterwijk: Wolf Legal Publishers.

Hohfeld, Wesley Newcomb (1913) *Some Fundamental Legal Conceptions as Applied in Judicial Reasoning*. In *Yale Law Journal*, Vol. 23, No. 1, pp. 16–59. New Haven, CT: Yale Law School.

Holmes, Oliver Wendell (1897) *The Path of the Law*. In *Harvard Law Review*, Vol. 10, No. 8, pp. 457–478. Cambridge, MA: The Harvard Law Review Association.

Houston, Sarina (2018) *How much does it Cost to Buy a Plane? A Guide to Aircraft Ownership Costs*. Dotdash. https://bit.ly/2RFK2gf.

Huang, Jiefang (2009) *Aviation Safety and ICAO*. Alphen aan den Rijn: Kluwer Law International.
(2017) *Security regulations: International requirements*. In Dempsey, Paul Stephen – Jakhu, Ram S. (eds.) *Routledge Handbook of Public Aviation Law*, pp. 137–161. Abingdon, UK & New York, NY: Routledge.

Huffman, Carl A. (2005) *Archytas of Tarentum: Pythagorean, Philosopher and Mathematician King*. Cambridge, UK: Cambridge University Press.

Hunt, Alan (1986) *The Theory of Critical Legal Studies*. In *Oxford Journal of Legal Studies*, Vol. 6, No. 1, pp. 1-45. Oxford, UK: Oxford University Press.

Huttunen, Mikko (2017) *Unmanned, Remotely Piloted, or Something Else? Analysing the Terminological Dogfight*. In *Air & Space Law*, Vol. 42, No. 3, pp. 349–368. Alphen aan den Rijn: Kluwer Law International.

(2019a) *The U-space Concept*. In *Air & Space Law*, Vol. 44, No. 1, pp. 69–90. Alphen aan den Rijn: Kluwer Law International.

(2019b) *Drone Operations in the Specific Category: A Unique Approach to Aviation Safety*. In *The Aviation and Space Journal*, Vol. 18, No. 2, pp. 2–21. Bologna: The Aviation and Space Journal.

(2019c) *Civil Unmanned Aircraft Systems and Security: The European Approach*. In *Journal of Transportation Security*, Vol. 12, No. 3–4, pp. 83–101. New York, NY: Springer.

Hänsenberger, Silvio (2018) *Die zivilrechtliche Haftung für autonome Drohnen unter Einbezug von Zulassungs- und Betriebsvorschriften*. Berlin & Bern: Carl Grossman Verlag.

Jasanoff, Sheila (1995) *Science at the Bar: Law, Science, and Technology in America*. Cambridge, MA: Harvard University Press.

(2004) *Ordering knowledge, ordering society*. In Jasanoff, Sheila (ed.) *States of Knowledge: The co-production of science and social order*, pp. 13–45. London, UK & New York, NY: Routledge.

Jenks, Chris (2009) *Law from Above: Unmanned Aerial Systems, Use of Force, and the Law of Armed Conflict*. In *North Dakota Law Review*, Vol. 85, No. 3, pp. 649–671. Grand Forks, ND: Univerty of North Dakota School of Law.

Joss, Simon – Durant, John (1995, eds.) *Public participation in science: The role of consensus conferences in Europe*. London, UK: Science Museum.

Kaal, Wulf A. (2014) *Evolution of Law: Dynamic Regulation in a New Institutional Economics Framework*. In Kaal, Wulf. A – Schmidt, Matthias – Schwartze, Andreas (eds.) *Festschrift zu Ehren von Christian Kirchner*, pp. 1211–1228. Tübingen: Mohr Siebeck.

Kaal, Wulf A. – Vermeulen, Erik P.M. (2017) *How to Regulate Disruptive Innovation—From Facts to Data*. In *Jurimetrics*, Vol. 57, No. 2, pp. 169–210. Chicago, IL: American Bar Association.

Kahn, Randolph (2016) *Law's Great Leap Forward: How Law Found a Way to Keep Pace with Disruptive Technological Change*. In *Business Law Today*, November 2016 (issue 11). Chicago, IL: American Bar Association.

Kaiser, Stefan (2006) *Legal Aspects of Unmanned Aerial Vehicles*. In *Zeitschrift für Luft- und Weltraumrecht*, Vol. 55, No. 3, pp. 344–363. Cologne: Institut für Luft- und Weltraumrecht der Universität zu Köln.

(2011) *UAVs and Their Integration into Non-segregated Airspace*. In *Air & Space Law*, Vol. 36, No. 2, pp. 161–172. Alphen aan den Rijn: Kluwer Law International.

Kaplow, Louis (1992) *Rules Versus Standards: An Economic Analysis*. In *Duke Law Journal*, Vol. 42, pp. 557–629. Durham, NC: Duke University School of Law.

Kean, Arnold (1982, ed.) *Essays in Air Law*. The Hague et al.: Martinus Nijhoff.

Keenan, Peter B. – Lester, Anthony – Martin, Peter (1966) *Shawcross and Beaumont on Air Law*, 3rd edition. London, UK: Butterworths.

Kelsen, Hans (1960/1967) *Pure Theory of Law*. Translated from the 2nd edition by Knight, Max. Berkeley and Los Angeles, CA: University of California Press. Originally *Reine Rechtslehre: Einleitung in die rechtswissenschaftliche Problematik*. Vienna: Franz Deuticke.

Kirby, Michael Donald (1977) *Science, Technology & Law Reform*. Paper presented at the *Monash University/Law Council of Australia Seminar on Science, Technology and the Law, Melbourne, 27 January 1977.*

(2008) *New Frontier: Regulating Technology by Law and 'Code'*. In Brownsword, Roger – Yeung, Karen (eds.) *Regulating Technologies: Legal Futures, Regulatory Frames and Technological Fixes*, pp. 367–388. Portland, OR: Hart Publishing.

Klabbers, Jan – Piiparinen, Touko (2013, eds.) *Normative Pluralism and International Law: Exploring Global Governance*. New York, NY: Cambridge University Press.

Kohler, Paul – Palmer, Norman (1998) *Information as Property*. In Palmer, Norman – McKendrick, Ewan (eds.) *Interests in Goods*, pp. 3–23. London, UK: LLP.

Klenka, Michal (2019) *Major Incidents That Shaped Aviation Security*. In *Journal of Transportation Security*, Vol. 12, No. 1, pp. 39–56. New York, NY: Springer.

Kline, Ronald R (2015) *Technological Determinism*. In Wright, James D. (ed.) *International Encyclopedia of the Social & Behavioral Sciences*, Vol. 24, pp. 109 2nd edition. Amsterdam: Elsevier.

Kolacz, Marta Katarzyna – Quintavalla, Alberto (2018) *The Conduit between Technological Change and Regulation*. In *Erasmus Law Review*, Vol. 11, No. 3, pp. 143–150. The Hague: Eleven International Publishing.

Kornmeier, Claudia (2012) *Der Einsatz von Drohnen zur Bildaufnahme: Eine luftverkehrsrechtliche und datenschutzrechtliche Betrachtung*. Berlin et al.: LIT Verlag.

Koskenniemi, Martti (1989/2005) *From Apology to Utopia: The Structure of International Legal Argument*. Cambridge, UK: Cambridge University Press. Originally Helsinki: Helsinki University Press.

Kosti, Nir – Levi-Faur, David – Mor, Guy (2019) *Legislation and regulation: three analytical distinctions*. In *The Theory and Practice of Legislation*, Vol. 7, No. 3, pp. 169–178. London, UK: Taylor & Francis Online.

Kronman, Anthony (1983) *Max Weber*. Stanford, CA: Stanford University Press.

Kuhn, Thomas S. (1962/1996) *The Structure of Scientific Revolutions*, 3rd edition. Chicago, IL: University of Chicago Press.

Kutschera, Wolfgang Rick (2016) *Drohnen: Rahmenbedingungen für ihre Verwendung in Österreich und der EU*. Riga: Saarbrücker Verlag für Rechtswissenschaften (OmniScriptum).

Laudan, Larry (1977) *Progress and Its Problems: Towards a Theory of Scientific Growth*. Berkeley and Los Angeles, CA: University of California Press.

Laurie, Graeme – Harmon, Shawn H.E. – Arzuaga, Fabiana (2012) *Foresighting Futures: Law, New Technologies, and the Challenges of Regulating for Uncertainty*. In *Law, Innovation and Technology*, Vol. 4, No. 1, pp. 1–33. Abingdon-on-Thames, UK: Taylor & Francis.

Law, John – Bijker, Wiebe E. (1992) *Postscript: Technology, Stability, and Social Theory*. In Bijker, Wiebe E. – Law, John (eds.) *Shaping Technology/Building Society: Studies in Sociotechnical Change*, pp. 290–308. Cambridge, MA: The MIT Press.

Lee, Maria (2017) *The Legal Institutionalization of Public Participation in the EU Governance of Technology*. In Brownsword, Roger – Scotford, Eloise – Yeung, Karen (eds.) *The Oxford Handbook of Law, Regulation, and Technology*, pp. 620–644. Oxford, UK: Oxford University Press.

Leenes, Ronald (2019) *Regulating New Technologies in Times of Change*. In Reins (ed.) *Regulating New Technologies in Uncertain Times*, pp. 3–17. The Hague: TMC Asser Press.

Leiser, Mark – Murray, Andrew (2017) *The Role of Non-State Actors and Institutions in the Governance of New and Emerging Digital Technologies*. In Brownsword, Roger – Scotford, Eloise – Yeung, Karen (eds.) *The Oxford Handbook of Law, Regulation, and Technology*, pp. 670–701. Oxford, UK: Oxford University Press.

Leiter, Brian (1996/2010) *American Legal Realism*. Patterson, Dennis (ed.) *A Companion to Philosophy of Law and Legal Theory*, 2nd edition, pp. 249–266. Oxford, UK: Blackwell. Originally in Patterson, Dennis (ed.) *Companion to Philosophy of Law and Legal Theory*, pp. 261–279.

(1998) *Realism, Hard Positivism, and Conceptual Analysis*. In *Legal Theory,* Vol. 4, No. 4, pp. 533–547. Cambridge, UK: Cambridge University Press.

(2001) *Legal Realism and Legal Positivism Reconsidered*. In *Ethics*, Vol. 111, No. 2, pp. 278–301. Chicago, IL: The University of Chicago Press.

Leloudas, George (2017) *Domestic regulation of security: The example of the European Union*. In Dempsey, Paul Stephen – Jakhu, Ram S. (eds.) *Routledge Handbook of Public Aviation Law*, pp. 162–179. Abingdon, UK & New York, NY: Routledge.

Lessig, Lawrence (1998) *The New Chicago School*. In *The Journal of Legal Studies*, Vol. 27, No. S2, pp. 661–691. Chicago, IL: The University of Chicago Press.

(2006) *Code: Version 2.0*. New York, NY: Basic Books.

Levy, Jack S. (2008) *Case Studies: Types, Designs, and Logics of Inference*. In *Conflict Management and Peace Science*, Vol. 25, No. 1, pp. 1–18. Thousand Oaks, CA: SAGE Publications.

Lezaun, Javier (2012) *The Pragmatic Sanction of Materials: Notes for an Ethnography of Legal Substances*. In *Journal of Law and Society*, Vol. 39, No. 1, pp. 20–38. Hoboken, NJ: Wiley on behalf of the Cardiff School of Law and Politics.

Lijphart, Arend (1971) *Comparative Politics and the Comparative Method*. In *The American Political Science Review*, Vol. 65, No. 3, pp. 682–693. Washington, DC: American Political Science Association.

Lindroos, Anja (2005) *Addressing Norm Conflicts in a Fragmented Legal System: The Doctrine of Lex Specialis*. In *Nordic Journal of International Law*, Vol. 74, No. 1, pp. 27–66. Leiden: Koninklijke Brill NV.

Ludlow, Karinne – Bowman, Diana M. – Gatof, Jake – Bennett, Michael G. (2015) *Regulating Emerging and Future Technologies in the Present*. In *NanoEthics*, Vol. 9, No. 2, pp. 151–163. Dordrecht et al.: Springer.

MacCormick, Neil (1986) *Chapter VI: Law, Morality and Positivism*. In MacCormick, Neil – Weinberger, Ota (eds.) *An Institutional Theory of Law: New Approaches to Legal Positivism*, pp. 127–144. Dordrect et al.: D. Reidel Publishing Company.

MacCormick, Neil – Weinberger, Ota (1986) *Introduction*. In MacCormick, Neil – Weinberger, Ota (eds.) *An Institutional Theory of Law: New Approaches to Legal Positivism*, pp. 1–30. Dordrect et al.: D. Reidel Publishing Company.

MacKenzie, Donald – Wajcman, Judy (1985) *Introductory Essay*. In MacKenzie, Donald – Wajcman, Judy (eds.) *The Social Shaping of Techology: How the refrigerator got its hum*, pp. 2–25. Milton Keynes, UK & Philadelphia, PA: Open University Press.

MacPherson, Ewen (2018) *Is the World Ready for Drones?* In *Air & Space Law*, Vol. 43, No. 2, pp. 149–178. Alphen aan den Rijn: Kluwer Law International.

Malloy, Timothy F. (2013) *Integrating technology assessment into government technology policy*. In Marchant, Gary E. – Abbott, Kenneth W. – Allenby, Braden (eds.) *Innovative Governance Models for Emerging Technologies*, pp. 108–135. Cheltenham, UK & Northampton, MA: Edward Elgar.

Mandel, Gregory N. (2009) *Regulating Emerging Technologies*. In *Law, Innovation and Technology*, Vol. 1, No. 1, pp. 75–92. Abingdon-on-Thames, UK: Taylor & Francis.

(2013) *Emerging technology governance*. In Marchant, Gary E. – Abbott, Kenneth W. – Allenby, Braden (eds.) *Innovative Governance Models for Emerging Technologies*, pp. 44–62. Cheltenham, UK & Northampton, MA: Edward Elgar.

(2017) *Legal Evolution in Response to Technological Change*. In Brownsword, Roger – Scotford, Eloise – Yeung, Karen (eds.) *The Oxford Handbook of Law, Regulation, and Technology*, pp. 225–245. Oxford, UK: Oxford University Press.

Mandel, Gregory N. – Marchant, Gary E. (2013) *Evolving technology regulation: Governance at a temporal distance*. In Leenes, Ronald E. – Kosta, Eleni (eds.) *Bridging Distances in Technology and Regulation*, Version of record, pp. 17–36. Oisterwijk: Wolf Legal Publishers.

Marchant, Gary E. (2011a) *The Growing Gap Between Emerging Technologies and the Law*. In Marchant, Gary E. – Allenby, Braden R. – Herkert, Joseph R. (eds.) *The Growing Gap Between Emerging Technologies and Legal-Ethical Oversight: The Pacing Problem*, pp. 19–33. Dordrecht et al.: Springer.

(2011b) *Addressing the Pacing Problem*. In Marchant, Gary E. – Allenby, Braden R. – Herkert, Joseph R. (eds.) *The Growing Gap Between Emerging Technologies and Legal-Ethical Oversight: The Pacing Problem*, pp. 199–205. Dordrecht et al.: Springer.

Marchant, Gary E. – Allenby, Braden R. – Herkert, Joseph R. (2011, eds.) *The Growing Gap Between Emerging Technologies and Legal-Ethical Oversight: The Pacing Problem*. Dordrecht et al.: Springer.

Marchant, Gary E. – Wallach, Wendell (2013) *Governing the governance of emerging technologies*. In Marchant, Gary E. – Abbott, Kenneth W. – Allenby, Braden (eds.) *Innovative Governance Models for Emerging Technologies*, pp. 136–152. Cheltenham, UK & Northampton, MA: Edward Elgar.

Marshall, Douglas (2009) *Unmanned Aerial Systems and International Civil Aviation Organization Regulations*. In *North Dakota Law Review*, Vol. 85, No. 3, pp. 693–713. Grand Forks, ND: Univerty of North Dakota School of Law.

(2015) "*What A Long Strange Trip It's Been": A Journey Through the FAA's Drone Policies and Regulations*. In *DePaul Law Review,* Vol. 65, No. 1, pp. 123–134. Chicago, IL: DePaul College of Law.

Maslaton, Martin (2018) *Granting Licenses according to Art. 21 a and Art. 21 b LuftVO for the Operation of Unmanned Aerial Vehicles*. In *Zeitschrift für Luft- und Weltraumrecht*, Vol. 67, No. 1, pp. 87–103. Cologne: Institut für Luft- und Weltraumrecht der Universität zu Köln.

Masutti, Anna (2009) *Proposals for the Regulation of Unmanned Air Vehicle Use in Common Airspace*. In *Air & Space Law*, Vol. 34, No. 1, pp. 1–12. Alphen aan den Rijn: Kluwer Law International.

(2018) *UAV Operations: The European Union Legal Framework on Privacy and Data Protection*. In *The Aviation & Space Journal*, Vol. 17, No. 3, pp. 2–6. Bologna: University of Bologna.

Masutti, Anna – Tomasello, Filippo (2018) *International Regulation of Non-Military Drones*. Cheltenham, UK: Edward Elgar.

Matte, Nicolas Mateesco (1981) *Treatise on Air-Aeronautical Law*. Montreal: Institute and Centre of Air and Space Law, Faculty of Law, McGill University.

Matwyshyn, Andrea M. (2007) *Technology, Commerce, Development, Identity*. In *Minnesota Journal of law, Science & Technology*, Vol. 8, No. 2, pp. 515–549. Minneapolis, MN: University of Minnesota Law School.

McMillan, John – Snelling, Jeanne (2017) *Equality: Old Debates, New Technologies*. In Brownsword, Roger – Scotford, Eloise – Yeung, Karen (eds.) *The Oxford Handbook of Law, Regulation, and Technology*, pp. 69–89. Oxford, UK: Oxford University Press.

Melville, Aaron L. (2001) *The Future of the Audio Home Recording Act of 1992: Has It Survived the Millennium Bug?* In *Boston University Journal of Science & Technology Law*, Vol. 7, No. 2, pp. 372–405. Boston, MA: Boston University School of Law.

Mendes de Leon, Pablo (2017) *Introduction to Air Law*, 10th edition. Alphen aan den Rijn: Kluwer Law International.

Michaelides-Mateou, Sofia – Erotokritou, Chrystel (2014) *Flying into the Future with UAVs: The Jetstrearm 31 Flight*. In *Air & Space Law*, Vol. 39, No. 2, pp. 111–130. Alphen aan den Rijn: Kluwer Law International.

Migala, Stephen J. (2017) *UAS: Understanding the Airspace of States*. In *Journal of Air Law and Commerce*, Vol. 82, No. 1, pp. 3–82. Dallas, TX: Southern Methodist University School of Law.

Miguel Molina, María Blanca de – Segarra-Oña, Marival (2018), *The Drone Sector in Europe*. In Miguel Moline, María Blanca de – Santamarina-Campos, Virginia (eds.), *Ethics and Civil Drones: European Policies and Proposals for the Industry*, pp. 7–33. Cham: Springer.

Milde, Michael (2012) *International Air Law and ICAO*, 2nd edition. The Hague: Eleven International Publishing.

Minkkinen, Panu (2013) *De Lege Ferenda: What is the 'Socio' of Legal Reasoning?* In Feenan, Dermot (ed.) *Exploring the 'Socio' of Socio-Legal Studies*, pp. 85–110. Basingstoke, UK: Palgrave Macmillan.

Mironenko Enerstvedt, Olga (2017) *Aviation Security, Privacy, Data Protection and Other Human Rights: Technologies and Legal Principles*. Cham: Springer.

Molchanov, Pavlo – Harmanny, Ronny I.A. – Wit, Jaco J.M. de – Egiazarian, Karen – Astola, Jaakko (2014) *Classification of small UAVs and birds by micro-Doppler signatures*. In *International Journal of Microwave and Wireless Technologies*, Vol. 6, No. 3/4, pp. 435–444. Cambridge, UK: Cambridge University Press.

Morgan, Jonathan (2017) *Torts and Technology*. In Brownsword, Roger – Scotford, Eloise – Yeung, Karen (eds.) *The Oxford Handbook of Law, Regulation, and Technology*, pp. 522–545. Oxford, UK: Oxford University Press.

Morris, Hugh (2017) *Why planes fly at 35,000 feet: The reason for high altitude flights*. Traveller. https://bit.ly/3bhaZ1F.

Munson, Kenneth (1988) World Unmanned Aircraft. London, UK: Jane's Publishing Company.

Murphy, Tim (1999) *BritCrits: Subversion and submission, past, present and future*. In *Law and Critique*, Vol. 10, No. 3, pp. 237–278. Alphen aan den Rijn: Kluwer Law International.

Navarro Tapia, Nadia (2020) *The Meanings of Victimhood 'From Below': How Victims of Mass Atrocity Use the Category of Victim in Colombia and its Relevance for Victims at the International Criminal Court*. Helsinki: Unigrafia.

Needham, Joseph (1965) *Science and Civilisation in China, Volume 4: Physics and Physical Technology, Part II: Mechanical Engineering*. Cambridge, UK: Cambridge University Press.

Niemi, Amelia Rose (2015) *Section 333: What We've Learned and Where We Need to Go*. In *DePaul Law Review,* Vol. 65, No. 1, pp. 135–153. Chicago, IL: DePaul College of Law.

Oswald, Ed – Lacoma, Tyler (2019) *The 10 most expensive drones that you (a civilian) can buy*. Digital Trends. https://bit.ly/34PHT6X.

Paddock, LeRoy – Masterton, Molly (2013) *An integrated framework for governing emerging technologies such as nanotechnology and synthetic biology*. In Marchant, Gary E. – Abbott, Kenneth W. – Allenby, Braden (eds.) *Innovative Governance Models for Emerging Technologies*, pp. 63–91. Cheltenham, UK & Northampton, MA: Edward Elgar.

Parayil, Govindan (2002) *Conceptualizing Technological Change: Theoretical and Empirical Explorations*. Lanham, MD: Rowman & Littlefield.

Parker, Christine – Braithwaite, John (2003) *Regulation*. In Cane, Peter – Tushnet, Mark (eds.) *The Oxford Handbook of Legal Studies*, pp. 119–145. Oxford, UK: Oxford University Press.

Pasquale, Frank – Cockfield, Arthur J. (2018) *Beyond Instrumentalism: A Substantivist Perspective on Law, Technology, and the Digital Persona*. In *Michigan State Law Review*, Vol. 2018, No. 4, pp. 821–868. East Lansing, MI: Michigan State University College of Law.

Peczenik, Aleksander (2005) *A Treatise of Legal Philosophy and General Jurisprudence, Volume 4 – Scientia Juris: Legal Doctrine as Knowledge of Law and as a Source of Law*. Dordrecht et al.: Springer.

Perritt, Henry H. Jr – Sprague, Eliot O. (2017) *Domesticating Drones: The Technology, Law, and Economics of Unmanned Aircraft*. Abingdon-on-Thames, UK: Routledge.

Pinch, Trevor J. – Bijker, Wiebe E. (1984) *The Social Construction of Facts and Artefacts: or How the Sociology of Science and the Sociology of Technology might Benefit Each Other*. In *Social Studies of Science*, Vol. 14, No. 3, pp. 399–411. London, UK et al.: SAGE Publications.

Plücken, Milan A. (2017) *Unbemannte Luftfahrzeugsysteme: Zulassungsvorgaben und -vorschriften der ICAO bzw. der EU*. Cologne: Carl Heymanns Verlag.

Posner, Richard (1990) *The Problems of Jurisprudence*. Cambridge, MA: Harvard University Press.

Price, Jeffrey C. – Forrest Jeffrey S. (2016) *Practical Aviation Security: Predicting and Preventing Future Threats*, 3rd edition. Oxford, UK: Elsevier.

Ragin, Charles C. (1997) *Turning the Tables: How Case-Oriented Research Challenges Variable-Oriented Research*. In Mjøset, Lars – Engelstad, Fredrik – Brochmann, Grete – Kalleberg, Ragnvald – Leira, Arnlaug (eds.) *Comparative Social Research, Volume 16: Methodological Issues in Comparative Social Science*, pp. 27–42. Greenwich, CT: JAI Press.

Raman, Sujatha (2015) *Science, uncertainty and the normative question of epistemic governance in policymaking*. In Cloatre, Emilie – Pickersgill, Martyn (eds.) *Knowledge, Technology and Law*, pp. 17–32. Abingdon, UK & New York, NY: Routledge.

Rapp, Friedrich (1978/1981) *Analytical Philosophy of Technology*. Translated by Carpenter, Stanley R. – Langenbruch, Theodor. Dordrecht: D. Reidel Publishing Company. Originally *Analytische Technikphilosophie*. Freiburg & Munich: Verlag Karl Alber.

Rapp, Geoffrey Christopher (2009) *Unmanned Aerial Exposure: Civil Liability Concerns Arising from Domestic Law Enforcement Employment of Unmanned Aerial Systems*. In *North Dakota Law Review*, Vol. 85, No. 3, pp. 624–648. Grand Forks, ND: University of North Dakota School of Law.

Rappert, Brian (2011) *Pacing Science and Technology with Codes of Conduct: Rethinking What Works*. In Marchant, Gary E. – Allenby, Braden R. – Herkert, Joseph R. (eds.) *The Growing Gap Between Emerging Technologies and Legal-Ethical Oversight: The Pacing Problem*, pp. 109–126. Dordrecht et al.: Springer.

Rassler, Don (2016) *Remotely Piloted Innovation: Terrorism, Drones and Supportive Technology*. West Point, NY: Combating Terrorism Center of the United States Military Academy.

Ravich, Timothy M (2009) *The Integration of Unmanned Aerial Vehicles into the National Airspace*. In *North Dakota Law Review*, Vol. 85, No. 3, pp. 597–622. Grand Forks, ND: University of North Dakota School of Law.

(2017) *Commercial Drone Law: Digest of U.S. and Global UAS Rules, Polices, and Practices*. Chicago, IL: American Bar Association.

Rayfuse, Rosemary (2017) *Public International Law and the Regulation of Emerging Technologies*. In Brownsword, Roger – Scotford, Eloise – Yeung, Karen (eds.) *The Oxford Handbook of Law, Regulation, and Technology*, pp. 500–521. Oxford, UK: Oxford University Press.

Raz, Joseph (1979) *The Authority of Law*. Oxford, UK: Oxford University Press.

Redfield, Isaac F. (1858) *A Practical Treatise Upon the Law of Railways*, 2nd edition. Boston, MA. Little, Brown and Company.

Reed, Chris (2007) *Taking Sides on Technology Neutrality*. In *SCRIPT-ed*, Vol. 4, No. 3, pp. 263–284. Edinburgh, UK: SCRIPT Centre for Studies in Intellectual Property and Technology Law.

Rip, Arie – Kemp, René (1998) *Technological Change*. In Rayner, Steve – Malone (eds.) *Human Choice and Climate Change*, Vol. 2, pp. 327–399. Columbus, OH: Battelle Press.

Roach Anleu, Sharyn L. (2000/2010) *Law and Social Change*, 2nd edition. London, UK et. al.: SAGE Publications.

Roma, Alfredo (2014) *Remotely Piloted Aircraft Systems: Privacy and Data Protection Implications*. In *The Aviation & Space Journal*, Vol. 13, No. 1, pp. 22–34. Bologna: University of Bologna.

Ross, Alf (1953/1959) *On Law and Justice*. Berkeley and Los Angeles, CA: University of California Press. Originally *Om ret og retfærdighed: En indførelse i den analytiske retsfilosofi*. Copenhagen: Nyt nordisk forlag Arnold Busck.

Ross, Daniel (2015) *Introduction: the UAS Dilemma: Unlimited Potential, Unresolved Concerns.* In *DePaul Law Review,* Vol. 65, No. 1, pp. 105–107. Chicago, IL: DePaul College of Law.

Rossi Dal Pozzo (2015) *EU Legal Framework for Safeguarding Air Passenger Rights*. Cham et al.: Springer.

Salmirinne, Heikki – Hyvönen, Eija – Karinen, Tuomo – Konnunaho, Jukka – Kurimo, Maija – Middleton, Maarit – Niiranen, Tero – Panttila, Hannu – Pasanen, Antti – Turunen, Pertti (2017) *UAV-MEMO-projekti, Osa I: Miehittämättömät ilma-alukset malminetsinnässä ja kaivostoiminnassa*. Report of Investigation 232. Geological Survey of Finland.

Samuelson, Pamela (1986) *Creating a New Kind of Intellectual Property: Applying the Lessons of the Chip Law to Computer Programs*. In *Minnesota Law Review*, Vol. 24, No. 2, pp. 241–277. Minneapolis, MN: University of Minnesota Law School.

Saner, Marc A. (2013) *The role of adaptation in the governance of emerging technologies*. In Marchant, Gary E. – Abbott, Kenneth W. – Allenby, Braden (eds.) *Innovative Governance Models for Emerging Technologies*, pp. 92–107. Cheltenham, UK & Northampton, MA: Edward Elgar.

Sarewitz, Daniel (2011) *Anticipatory Governance of Emerging Technologies*. In Marchant, Gary E. – Allenby, Braden R. – Herkert, Joseph R. (eds.) *The Growing Gap Between Emerging Technologies and Legal-Ethical Oversight: The Pacing Problem*, pp. 95–105. Dordrecht et al.: Springer.

Sato, Akira (2003) *Civil UAV Applications in Japan and Related Safety & Certification*. Shizuoka: Yamaha.

Schauer, Frederick (1991) *Playing by the Rules: A Philosophical Examination of Rule-Based Decision-Making in Law and in Life*. Oxford, UK: Clarendon Press.

(2010) *Was Austin Right after All? On the Role of Sanctions in a Theory of Law*. In *Ratio Juris*, Vol. 23, No. 1, pp. 1–21. Oxford, UK: Blackwell Publishing.

Schiavo, Mary Fackler (2008) *A Chronology of Attacks against Civil Aviation*. In Thomas, Andrew (ed.) *Aviation Security Management*, Vol. 1, pp. 142–260. Westport, CT: Greenwood.

Schiff Berman, Paul (2012) *Global Legal Pluralism: A Jurisprudence of Law Beyond Borders*. New York, NY: Cambridge University Press.

Schlag, Pierre (1985) *Rules and Standards*. In *UCLA Law Review*, Vol. 33, No. 2, pp. 379–430. Los Angeles, CA: UCLA School of Law.

Schneid, Thomas D. (2018) *Safety Law: Legal Aspects in Occupational Safety and Health*. Boca Raton, FL: CRC Press.

Schubert, Francis (2014) *The Integration of Remotely Piloted Aircraft in the Air Navigation Services System*. In *Annals of Air and Space Law*, Vol. 39, pp. 129–162. Montreal: Institute and Centre of Air and Space Law, Faculty of Law, McGill University.

Schuck, Peter H. (2000) *The Limits of Law: Essays on Democratic Governance*. Boulder, CO: Westview Press.

Schwartz Cowan, Ruth (1987/2012) *The Consumption Junction: A Proposal for Research Strategies in the Sociology of Technology*. In Bijker, Wiebe E. – Hughes, Thomas P. – Pinch, Trevor (eds.) *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, Anniversary Edition, pp. 253–272. Cambridge, MA: The MIT Press.

Schön, Donald (1967) *Technology and Change: The Impact of invention and innovation on American social and economic development*. New York, NY: Dell Publishing.

Schweber, Howard (2004) *The Creation of American Common Law, 1850–1880*. Cambridge, UK: Cambridge University Press.

Sclove, Richard (2010) *Reinventing Technology Assessment: A 21st Century Model*. Washington, DC: Woodrow Wilson International Center for Scholars.

Scott, Benjamyn Ian (2015) *The First UK Conviction for the Illegal Use of an Unmanned Aircraft and how it Can Help Improve Regulations within the EU*. In *The Aviation & Space Journal*, Vol. 14, No. 1, pp. 11–22. Bologna: University of Bologna.

(2016, ed.) *The Law of Unmanned Aircraft Systems: An Introduction to the Current and Future Regulation under National, Regional and International Law*. In *Aerospace Law and Policy Series*, Vol. 11. Alphen aan den Rijn: Kluwer Law International.

Scott, Benjamyn Ian – Trimarchi, Andrea (2020) *Fundamentals of International Aviation Law and Policy*. Abingdon-on-Thames, UK et al.: Routledge.

Selznick, Philip (1985) *Focusing Organisational Research on Regulation*. In Noll, Roger G. (ed.) *Regulatory Policy and the Social Sciences*, pp. 363–367. Berkeley, CA: University of California Press.

Shaw, Malcolm N. (1982) *Territory in International Law*. In *Netherlands Yearbook of International Law*, Vol. 13, p. 61–91. The Hague: TMC Asser Press.

Shoaps, Robin – Stanley, Sarah (2016) *"Don't Say Drone": Hits and Misses in a Rhetorical Project of Naming*. In Vanguri, Star Medzerian (ed.) *Rhetorics of Names and Naming*, pp. 102–117. New York, NY & Abingdon, UK: Routledge.

Singer, Jana (2006) *Marriage, Biology, and Paternity: The Case for Revitalizing the Marital Presumption*. In *Maryland Law Review*, Vol. 65, No. 1, pp. 246–270. Baltimore, MD: University of Maryland Francis King Carey School of Law.

Sloggett, Dave (2014) *Drone Warfare: The Development of Unmanned Aerial Conflict*. Barnsley, UK: Pen & Sword Aviation.

Smith, Merritt R. – Marx, Leo (1994, eds.) *Does Technology Drive History? The Dilemma of Technological Determinism*. Cambridge, MA: MIT Press.

Smits, Jan (2012) *The Mind and Method of the Legal Academic*. Cheltenham, UK: Edward Elgar.

Spijkert, Lennaert – Lozano, Juan Carlos (2016) *Information Paper IP/2 presented to the 5th meeting of ICAO RPAS Panel*. Internal Document.

Staudenmeier, John M. (1983/1984) *What SHOT Hath Wrought and what SHOT Hath Not: Reflections on 25 Years of the History of Technology*. Paper presented at the 25th Annual Meeting of Society for the History of Technology. Also in *Technology and Culture*, Vol. 25, No. 4, pp. 707–730. Baltimore, MD: The Johns Hopkins University Press and the Society for the History of Technology.

Stewart, Richard B. (1981) *Regulation, Innovation, and Administrative Law: A Conceptual Framework*. In *California Law Review*, Vol. 69, No. 5, pp. 1256–1377. Berkeley, CA: University of California.

Stirling, Andy (2017) *Precaution in the Governance of Technology*. In Brownsword, Roger – Scotford, Eloise – Yeung, Karen (eds.) *The Oxford Handbook of Law, Regulation, and Technology*, pp. 645–669. Oxford, UK: Oxford University Press.

Stokes, Elen (2012) *Nanotechnology and the Products of Inherited Regulation*. In *Journal of Law and Society*, Vol. 39, No. 1, pp. 93–112. Hoboken, NJ: Wiley on behalf of the Cardiff School of Law and Politics.

Stokes, Elen – Bowman, Diana M. (2012) *Looking Back to the Future of Regulating New Technologies: The Cases of Nanotechnologies and Synthetic Biology*. In *European Journal of Risk Regulation*, Vol. 3, No. 2, pp. 235–241. Cambridge, UK: Cambridge University Press.

Stolaroff, Joshuah K. – Samaras, Constantine – O'Neill, Emma R. – Lubers, Alia – Mitchell, Alexandra S. – Ceperley, Daniel (2018) *Energy use and life cycle greenhouse gas emissions of drones for commercial package delivery*. In *Nature Communications*, Vol. 9, art. No. 409. London, UK: Nature Research.

Stone, Julius (1964) *Legal System and Lawyers' Reasoning*. Stanford, CA: Stanford University Press.

Straub, Jeremy – Vacek, Joe – Nordlie, John (2014) *Considering Regulation of Small Unmanned Aerial Systems in the United States*. In *Air & Space* Law, Vol. 39, No. 4/5, pp. 275–293. Alphen aan den Rijn: Kluwer Law International.

Sun, Hongbo – Oh, Beom-Seok – Guo, Xin – Lin, Zhiping (2019) *Improving the Doppler Resolution of Ground-Based Surveillance Radar for Drone Detection. In IEEE Transactions on Aerospace and Electronic Systems*, Vol. 55, No. 6, pp. 3667–3673. Piscataway, NJ: Institute of Electrical and Electronics Engineers.

Sunstein, Cass R. (1996/2018) *Legal Reasoning and Political Conflict*. New York, NY: Oxford University Press.

Sweet, Kathleen M. (2008) *Aviation and Airport Security: Terrorism and Safety Concerns*, 2nd edition. Boca Raton, FL: CRC Press.

Toh, Kevin (2008) *An Argument against the Social Fact Thesis (And Some Additional Preliminary Steps towards a New Conception of Legal Positivism)*. In *Law and Philosophy*, Vol. 27, No. 5, pp. 445–504. Dordrecht et al.: Springer.

Tooley, Mike – Wyatt, David (2007/2018) *Aircraft Communications and Navigation Systems*, 2nd edition. Abingdon-on-Thames, UK: Routledge. Originally Amsterdam: Butterworth-Heinemann.

Torens, Christoph – Dauer, Johann C. – Adolf, Florian (2018) *Towards Autonomy and Safety for Unmanned Aircraft Systems*. In Durak, Umut – Becker, Jürgen – Hartmann, Sven – Voros, Nikolaos S. (eds.) *Advances in Aeronautical Informatics: Technologies Towards Flight 4.0*, pp. 105–120. Cham: Springer.

Tranter, Kieran (2002) *Terror in the Texts: Technology – Law – Future*. In *Law and Critique*, Vol. 13, No. 1, pp. 75–99. Alphen aan den Rijn: Kluwer Law International.

(2005) *"The History of the Haste-Wagons": The Motor Car Act 1909 (Vic), Emergent Technology and the Call for Law*. In *Melbourne University Law Review*, Vol. 29, No. 3, pp. 843–879. Melbourne: Melbourne Law School.

(2007) *Nomology, Ontology, and Phenomenology of Law and Technology*. In *Minnesota Journal of Law, Science & Technology*, Vol. 8, No. 2, pp. 449–474. Minneapolis, MN: University of Minnesota Law School.

(2011a) *The Law and Technology Enterprise: Uncovering the Template to Legal Scholarship on Technology*. In *Law, Innovation and Technology*, Vol. 3, No. 1, pp. 31–83. Abingdon-on-Thames, UK: Taylor & Francis.

(2011b) *The Laws of Technology and the Technology of Law*. In *Griffith Law Review*, Vol. 20, No. 4, pp. 753–762. Abingdon-on-Thames, UK: Taylor & Francis.

(2017) *Disrupting Technology Disrupting Law*. In *Law, Culture and the Humanities* (not assigned to an issue). Thousand Oaks, CA: SAGE Publications.

Tribe, Laurence H. (1973a) *Channeling Technology through Law*. Chicago, IL: The Bracton Press.

(1973b) *Technology Assessment and the Fourth Discontinuity: The Limits of Instrumental Rationality*. In *Southern California Law Review*, Vol. 46, No. 3, pp. 617–660. Los Angeles, CA: University of Southern California Gould School of Law.

Tuominen, Tomi (2017) *The European Constitution and the Eurozone Crisis: A Critique of European Constitutional Pluralism*. Acta Universitatis Lapponiensis 363. Rovaniemi: University of Lapland Press.

Tuori, Kaarlo (2002/2016) *Critical Legal Positivism*. Abingdon-on-Thames, UK: Routledge. Originally Aldershot, UK: Ashgate.

(2006) *Self-Description and External Description of the Law*. In *No Foundations: Journal of Extreme Legal Positivism*, Vol. 2, pp. 28–43.

(2017) *The pluralism of European fundamental rights law*. In Douglas-Scott, Sionaidh – Hatzis, Nicholas (eds.) Research Handbook on EU Law and Human Rights, pp. 35–57. Cheltenham, UK & Northampton, MA: Edward Elgar.

Unger, Roberto Mangabeira (1975) *Knowledge and Politics*. New York, NY: The Free Press.

Vacek, Joseph J. (2009) *Big Brother Will Soon Be Watching—or Will He? Constitutional, Regulatory, and Operational Issues Surrounding the Use of Unmanned Aerial Vehicles in Law Enforcement*. In *North Dakota Law Review*, Vol. 85, No. 3, pp. 674–692. Grand Forks, ND: Univerty of North Dakota School of Law.

Vandenbroucke, Jan P. (2001) *In Defense of Case Reports and Case Series*. In *Annals of Internal Medicine*, Vol. 134, No. 4, pp. 330–334. Philadelphia, PA: American College of Physicians.

Vasigh, Bijan – Fleming, Kenneth – Humphreys, Barry (2014) *Foundations of Airline Finance: Methodology and Practice*, 2nd edition. Abingdon-on-Thames, UK: Routledge.

Vergès, Etienne (2014) *Scientific and Technological Evolution through the Legal Prism: Visions of a Multi-Faceted Relationship through the Lens of French and EU Law*. In *Law, Innovation and Technology*, Vol. 6, No. 1, pp. 74–93. Abingdon-on-Thames, UK: Taylor & Francis.

Vermaas, Pieter – Kroes, Peter – Poel, Ibo van de – Franssen, Maarten – Houkes, Wybo (2011) *A Philosophy of Technology: From Technical Artefacts to Sociotechnical Systems*. San Rafael, CA: Morgan & Claypool.

Vile, Maurice John Crawley (1998) *Constitutionalism and the Separation of Powers*, 2nd edition. Indianapolis, IN: Liberty Fund.

Vismann, Cornelia (2008) *Files: Law and Media Technology*. Translated by Winthrop-Young, Geoffrey. Stanford, CA: Stanford University Press.

Weber, Max (1907/1977) *Critique of Stammler*. New York, NY: Free Press. Originally *R. Stammlers "Überwindung" der materialistischen Geschichtsauffassung*. Tübingen: JCB Mohr.

Weeramantry, Christopher (1983) *The Slumbering Sentinels: Law and Human Rights in the Wake of Technology*. Melbourne: Penguin.

Weinberger, Ota (1986) *Chapter V: Beyond Positivism and Natural Law*. In MacCormick, Neil – Weinberger, Ota (eds.) *An Institutional Theory of Law: New Approaches to Legal Positivism*, pp. 111–126. Dordrecht et al.: D. Reidel Publishing Company.

Weiss, Richard – Nicola, Stefan (2019) *Flying Taxi Startups Target Asia Debut Using European Technology*. Bloomberg. https://bloom.bg/2VzUoiW.

Werbach, Kevin (2004) *Supercommons: Toward a Unified Theory of Wireless Communication*. In *Texas Law Review*, Vol. 82, No. 4, pp. 863–974. Austin, TX: University of Texas School of Law.

Wexler, Lesley (2015) *Foreign Drone Claims*. In *DePaul Law Review,* Vol. 65, No. 1, pp. 155–170. Chicago, IL: DePaul College of Law.

White, James Boyd (1985) *Law as Rhetoric, Rhetoric as Law: The Arts of Cultural and Communal Life*. In *University of Chicago Law Review*, Vol. 52, No. 3, pp. 684–702. Chicago, IL: The University of Chicago.

White, Jeremy (2018) *Ehang's people-carrying drone is flying humans around rural China*. Wired. https://bit.ly/3cqcTNl.

Wiener, Jonathan B. (2004) *The regulation of technology, and the technology of regulation*. In *Technology in Society*, Vol. 26, Nos. 2–3, pp. 483–500. Amsterdam: Elsevier.

Williams, Robin M. Jr. (1967) *Individual and Group Values*. In *The Annals of the American Academy of Political and Social Science*, Vol. 371, No. 1, pp. 20–37. Thousand Oaks, CA: SAGE Publications in association with the American Academy of Political and Social Science.

(1977) *Change and Stability in Values and Value Systems: A sociological Perspective*. In Rokeach, Milton (ed.) *Understanding Human Values: Individual and Societal*, pp. 15–46. New York, NY: Free Press.

Wilson, James Q. (1980) *The politics of regulation*. In Wilson, James Q. (ed.) *The Politics of Regulation*, pp. 357–394. New York, NY: Basic Books.

Winner, Langdon (1978) *Autonomous Technology: Technics-out-of-Control as a Theme in Political Thought*. Cambridge, MA and London, UK: MIT Press.

Wu, Tim (2011) *Agency Threats*. In *Duke Law Journal*, Vol. 60, No. 8, pp. 1841–1857. Durham, NC: Duke University School of Law.

Yin, Robert K. (2014) *Case Study Research: Design and Methods*, 5th edition. Los Angeles, CA: SAGE Publications.

Završnik, Aleš (2016, ed.) *Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance*. Cham et al.: Springer.

International Agreements, Arrangements, Declarations, and Protocols

Agreement between the European Community and the Swiss Confederation on Air Transport. OJEU 2002 L 114/480. Done 21 June 1999, in force since 1 June 2002.

Agreement on the European Economic Area. OJEU 1994, L 1/3; 1793 UNTS 3. Done 2 May 1992, in force 1 January 1994.

Charter of the United Nations (UN Charter). 1 UNTS XVI. Done 26 June 1945, in force since 24 October 1945.

Convention for the Suppression of Unlawful Seizure of Aircraft (Hague Convention). ICAO doc 8920; 860 UNTS 105. Done 16 December 1970, in force since 14 October 1971.

Convention for the Unification of Certain Rules for International Carriage by Air (Montreal Convention). 2242 UNTS 309, ICAO Doc 4698. Done 28 May 1999, in force since 4 November 2003.

Convention on Commercial Aviation (Havana Convention). 129 LNTS 223. Done 20 February 1928, in force until 4.4.1947.

Convention on International Civil Aviation, consolidated version (Chicago Convention). 15 UNTS 295, ICAO Doc 7300/9. Done 7 December 1944, in force since 4 April 1947.

Convention on International Interests in Mobile Equipment (Cape Town Convention). 2307 UNTS 285, ICAO Doc 9793. Done 16 November 2001, in force since 1 March 2006.

Convention on Offences and Certain Other Acts Committed on Board Aircraft (Tokyo Convention). 704 UNTS 219, ICAO doc 8364. Done 14 September 1963, in force since 4 December 1969.

Convention Relating to the Regulation of Aerial Navigation (Paris Convention). 11 LNTS 173. Done 13 October 1919, in force between 1 June 1922 and 4 April 1947.

International Covenant on Civil and Political Rights. 999 UNTS 171. Done 19 December 1966, in force since 23 March 1976.

International Telecommunication Union Radio Regulations. International Telecommunication Union (2016).

Protocol No. 4 to the Convention for the Protection of Human Rights and Fundamental Freedoms. Done 16 September 1963, in force since 2 May 1968.

Protocol Relating to Amendments to Articles 3, 5, 7, 15, 34, 37, 41, 42, and Final Clauses of the Aerial Navigation Convention of October 13, 1919. Done 15 June 1929, in force between 17 May 1933 and 4 April 1947. 138 LNTS 418.

Protocol to the Convention on International Interests in Mobile Equipment on Matters Specific to Aircraft Equipment. 2367 UNTS 517, ICAO Doc 9794. Done 16 November 2001, in force since 1 March 2006.

Universal Declaration of Human Rights. In *United Nations General Assembly Resolution 217 (III) A*. Adopted 10 December 1948.

Working Arrangement between the European Aviation Safety Agency (EASA) and the State Aviation Administration of Ukraine (SAAU). Done and in force since 18 January 2016.

Documents of the International Civil Aviation Organization

Annex 1: Personnel Licensing, 12th edition. Annex to the *Convention on International Civil Aviation* (2018).

Annex 2: Rules of the Air, 10th edition. Annex to the *Convention on International Civil Aviation* (2005, as amended in 2018).

Annex 6: Operation of Aircraft. In three Parts – 11th, 10th, and 9th edition, respectively. Annex to the *Convention on International Civil Aviation* (2018).

Annex 7: Aircraft Nationality and Registration Marks, 6th edition. Annex to the *Convention on International Civil Aviation* (2012).

Annex 8: Airworthiness of Aircraft, 12th edition. Annex to the *Convention on International Civil Aviation* (2018).

Annex 9: Facilitation, 15th edition. Annex to the *Convention on International Civil Aviation* (2017).

Annex 10: Aeronautical Telecommunications. In five Volumes – 6th, 6th, 2nd, 5th, and 3rd edition, respectively. Annex to the *Convention on International Civil Aviation* (2006–2014).

Annex 11: Air Traffic Services, 15th edition. Annex to the *Convention on International Civil Aviation* (2018).

Annex 13: Aircraft Accident and Incident Investigation, 11th edition. Annex to the *Convention on International Civil Aviation* (2016).

Annex 14: Aerodromes. In two Volumes – 8th and 4th edition, respectively. Annex to the *Convention on International Civil Aviation* (2013–2018).

Annex 16: Environmental Protection. In four Volumes – 8th, 4th, 1st, and 1st edition, respectively. Annex to the *Convention on International Civil Aviation* (2017–2018).

Annex 17: Security, 10th edition. Annex to the *Convention on International Civil Aviation* (2017).

ICAO ASBU Documentation (updated regularly). https://bit.ly/2XEapXI.

ICAO Assembly Resolution A1-31: Definition of International Standards and Recommended Practices. In *Resolutions Adopted by the First Assembly*, pp. 27–29 (1947).

ICAO Assembly Resolution A35-5: Consolidated statement of continuing ICAO policies and practices related to environmental protection. In *Resolutions Adopted by the Assembly, 35th Session*, pp. 5–23 (2004).

ICAO Assembly Resolution A35-15: Consolidated statement of continuing ICAO policies and practices related to a global air traffic management (ATM) system and communications, navigation and surveillance/air traffic management (CNS/ATM) systems. In *Resolutions Adopted by the Assembly, 35th Session*, pp. 68–71 (2004).

ICAO Circular 328: Unmanned Aircraft Systems. Cir 328, AN/190 (2011).

ICAO Document 4444: Procedures for Air Navigation Services – Air Traffic Management (PANS-ATM), 16th edition (2016).

ICAO Document 8973 – Restricted: Aviation Security Manual, 10th edition (2017).

ICAO Document 9613: Performance-based Navigation (PBN) Manual, 3rd edition. AN/937 (2008).

ICAO Document 9713: International Civil Aviation Vocabulary, 3rd edition (2007).

ICAO Document 9760: Airworthiness Manual, 3rd edition (2013).
ICAO Document 9854: Global Air Traffic Management Operational Concept, 1st edition (2005).
ICAO Document 9859: Safety Management Manual (SMM), 3rd edition (2013).
ICAO Document 9869: Performance-based Communication and Surveillance (PBCS) Manual, 2nd edition (2017).
ICAO Document 9985 – Restricted: Air Traffic Management Security Manual, 1st edition (2013).
ICAO Document 10019: Manual on Remotely Piloted Aircraft Systems (RPAS Manual). AN/507 (2015).
ICAO UAS Toolkit (updated regularly). https://bit.ly/2VG4grc.
ICAO Working Paper AN-WP/7699: Determination of a Definition of Aviation Safety (2001).
ICAO Working Paper LC/29-WP/2-1: Secretariat Study on "Civil/State Aircraft" (1994).
ICAO Working Paper LC/37-WP/2-5: Clarification of Applicability of the Chicago Convention and SARPs to Certain Categories of RPAS/UAS (2018).
Status of the Convention on International Civil Aviation (as of 2020). https://bit.ly/3aNi1d9.

Documents of the European Union

Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Commission Implementing Regulation (EU) 2019/947. Issued 9 October 2019.
Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Part-UAS. Issued 9 October 2019.
Certification Specifications and Acceptable Means of Compliance for Large Aeroplanes (CS-25). Issued 17 October 2003, as amended to current date.
Certification Specifications and Acceptable Means of Compliance for Normal-Category Aeroplanes (CS-23). Issued 14 November 2003, as amended to current date.
Commission Communication (1999) 539: Towards a new framework for Electronic Communications infrastructure and associated services. Issued 10 November 1999.
Commission Communication (2014) 207: A new era for aviation – Opening the aviation market to the civil use of remotely piloted aircraft systems in a safe and sustainable manner. Issued 8 April 2014.
Commission Delegated Regulation (EU) 2019/945 of 12 March 2019 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems. OJEU L 152/1.
Commission Implementing Regulation (EU) No 923/2012 of 13 October 2012 laying down the common rules of the air and operational provisions regarding services and procedures in air navigation and amending Implementing Regulation (EU) No 1035/2011 and Regulations (EC) No 1265/2007, (EC) No 1794/2006, (EC) No 730/2006, (EC) No 1033/2006 and (EU) No 255/2010. OJEU L 281/1.
Commission Implementing Regulation (EU) 2015/1998 of 5 November 2015 laying down detailed measures for the implementation of the common basic standards on aviation security. OJEU L 299/1.
Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft. OJEU L 152/45.
Commission Proposal (2015) 613 for a Regulation of the European Parliament and of the Council of 7 December 2015 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and repealing Regulation (EC) No 216/2008 of the European Parliament and of the Council.
Commission Regulation (EC) No 272/2009 of 2 April 2009 supplementing the common basic standards on civil aviation security laid down in the Annex to Regulation (EC) No 300/2008 of the European Parliament and of the Council. OJEU L 91/7.

Commission Regulation (EU) No 1178/2011 of 25 November 2011 laying down technical requirements and administrative procedures related to civil aviation aircrew pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council. OJEU L 311/1.

Commission Regulation (EU) No 1332/2011 of 16 December 2011 laying down common airspace usage requirements and operating procedures for airborne collision avoidance. OJEU L 336/20.

Commission Regulation (EU) No 748/2012 of 3 August 2012 laying down implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations. OJEU L 224/1.

Commission Regulation (EU) No 965/2012 of 5 October 2012 laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council (consolidated text). OJEU L 296.

Commission Regulation (EU) No 69/2014 of 28 January 2014 amending Regulation (EU) No 748/2012 laying down implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations. OJEU L 23/12.

Commission Regulation (EU) No 139/2014 of 14 February 2014 laying down requirements and administrative procedures related to aerodromes pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council. OJEU L 44/1.

Commission Regulation (EU) No 1321/2014 of 17 December 2014 on the continuing airworthiness of aircraft and aeronautical products, parts and appliances, and on the approval of organisations and personnel involved in these tasks. OJEU L 362/1.

Commission Regulation (EU) 2015/640 of 23 April 2015 on additional airworthiness specifications for a given type of operations and amending Regulation (EU) No 965/2012. OJEU L 106/18.

Decision of the EEA Joint Committee No 179/2004 of 9 December 2004 amending Annex XIII (Transport) to the EEA Agreement. OJEU 2005 L 133/37.

Decision of the EEA Joint Committee No 163/2011 of 19 December 2011 amending Annex XIII (Transport) to the EEA Agreement. OJEU 2012 L 76/51.

Decision No 768/2008/EC of the European Parliament and of the Council of 9 July 2008 on a common framework for the marketing of products, and repealing Council Decision 93/465/EEC. OJEU L 218/82.

Directive 2002/21/EC of the European Parliament and of the Council of 7 March 2002 on a common regulatory framework for electronic communications networks and services. OJEU L 108/35.

Directive 2009/48/EC of the European Parliament and of the Council of 18 June 2009 on the safety of toys. OJEU L 170/1.

Draft Commission Delegated Regulation on unmanned aircraft intended for use in the "open" category, and on third-country operators of unmanned aircraft systems. European Commission (2018).

Draft Commission Implementing Regulation on the rules and procedures for the operation of unmanned aircraft. European Commission (2018).

Draft Commission Implementing Regulation on a high-level regulatory framework for the U-space. European Commission (2020).

Drones Helsinki Declaration. European Commission (22 November 2017).

EASA Advance Notice of Proposed Amendment (NPA) 16-2005: Policy for Unmanned Aerial Vehicle (UAV) Certification. EASA (2005).

EASA Advance Notice of Proposed Amendment 2015-10: Introduction of a regulatory framework for the operation of drones (31 July 2015).

EASA Comment-Response Document 2012-10: Transposition of Amendment 43 to Annex 2 of the Chicago Convention on remotely piloted aircraft systems (RPAS) into common rules of the air (2013).
EASA Notice of Proposed Amendment 2014-09: Transposition of Amendment 43 to Annex 2 to the Chicago Convention on remotely piloted aircraft systems (RPAS) into common rules of the air (3 April 2014).
EASA Notice of Proposed Amendment 2017-05 (A): introduction of a regulatory framework for the operation of drones – Unmanned aircraft system operations in the open and specific category (4 May 2017).
EASA Notice of Proposed Amendment 2017-05 (B): introduction of a regulatory framework for the operation of drones – Unmanned aircraft system operations in the open and specific category (4 May 2017).
EASA Opinion No 01/2018: Introduction of a regulatory framework for the operation of unmanned aircraft systems in the 'open' and 'specific' categories.
EASA Opinion No 01/2020: High-level regulatory framework for the U-space (13 March 2020).
EASA Policy Statement E.Y013-01: Airworthiness Certification of Unmanned Aircraft Systems *(UAS)* (2009).
EASA Safety Directive 2019-01: Boeing 737-8 MAX and 737-9 MAX - Suspension of Flight Operations (2019).
EASA Technical Opinion: Introduction of a regulatory framework for the operation of unmanned aircraft (2015).
Eurocontrol ACAS Guide: Airborne Collision Avoidance, 3rd edition. Eurocontrol (2017).
European ATM Master Plan: Digitalising Europe's Aviation Infrastructure. SESAR (2020).
European ATM Master Plan: Roadmap for the safe integration of drones into all classes of airspace (SESAR 2018).
European Drones Outlook Study: unlocking the value for Europe. SESAR (2016).
Privacy Code of Conduct: A practical guide to privacy and data protection requirements for drone operators and pilots. DroneRules.eu (2018).
"Prototype" Commission Regulation on Unmanned Aircraft Operations. EASA (22 August 2016).
Regulation (EC) No 1592/2002 of the European Parliament and of the Council of 15 July 2002 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency. OJEU L 240/1. No longer in force.
Regulation (EC) No 216/2008 of the European Parliament and of the Council 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. OJEU L 79/1. No longer in force.
Regulation (EC) No 300/2008 of the European Parliament and of the Council of 11 March 2008 on common rules in the field of civil aviation security and repealing Regulation (EC) No 2320/2002. OJEU L 97/72.
Regulation (EC) No 1008/2008 of the European Parliament and of the Council of 31 October 2008 on common rules for the operation of air services in the Community. OJEU L 293/3.
Regulation (EU) 2016/679 of the European Parliament and of the Council 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). OJEU L 119/1.

Regulation (EU) 2018/1139 of the European Parliament and of the Council of 22 August 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and amending Regulations (EC) No 2111/2005, (EC) No 1008/2008, (EU) No 996/2010, (EU) No 376/2014 and Directives 2014/30/EU and 2014/53/EU of the European Parliament and of the Council, and repealing Regulations (EC) No 552/2004 and (EC) No 216/2008 of the European Parliament and of the Council and Council Regulation (EEC) No 3922/91. OJEU L 212/1.

Riga Declaration on Remotely Piloted Aircraft (drones): "Framing the Future of Aviation". European Commission (6 March 2015).

SESAR JU GOF U-space project: Final demo with piloted air taxi flight successfully completed. Media release. SESAR (2019).

Towards the Development of Civil Applications of Unmanned Aircraft Systems (UAS): A Strategy for the European Union (Draft). European Commission (2012).

U-space Blueprint. SESAR (2017).

UAS ATM Flight Rules: Discussion Document, edition 1.1. Eurocontrol (2018).

UAV Task-Force Final Report: A Concept for European Regulations for Civil Unmanned Aerial Vehicles (UAVs). Joint Aviation Authorities & Eurocontrol (2004).

Warsaw Declaration: "Drones as a leverage for jobs and new business opportunities". European Commission (24 November 2016).

Domestic Legislation

Act on Police Administration (110/1992) as amended. Finland. Issued 14 February 1992, in force since 1 May 1992.

Act on Transport Services (320/2017). Finland. Issued 24 May 2017, in force since 1 July 2018. Note: as of today, the English translation does not incorporate provisions on aviation.

Advisory Circular AIR T16-6 on the airworthiness monitoring of air radio and navigation equipment. Finnish Transport and Communications Agency. Issued and in force since 8 January 1990.

Arrêté du 11 avril 2012 (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 per-sonnes qui les utilisent). NOR: DEVA1206042A. France. In force between 11 April 2012 and 1 January 2016.

Aviation Act (864/2014). Finland. Issued 7 November 2014, in force since 13 November 2014.

Aviation Regulation AIR M1-2 on aircraft nationality and registration markings. Finnish Transport and Communications Agency. Issued 27 September 2016, in force since 28 September 2016.

Aviation Regulation PEL M2-70 on ultralight pilots' licences. Finnish Transport and Communications Agency. Issued 5 June 2019, in force since 6 June 2019.

Civil Aviation Act 1982 (as amended). United Kingdom. Issued 27 May 1982, in force since 27 August 1982.

Code of Laws of the United States of America (US Code).

Information Society Code (917/2014). Finland. Issued 7 November 2014, in force since 1 January 2015.

Luftverkehrsgesetz (as amended). Germany. Issued 1 August 1922, in force since 1 October 1923.

OPS M1-32: Use of Remotely Piloted Aircraft and Model Aircraft (2015). Finnish Transport and Communications Agency. In force between 9 October 2015 and 1 January 2017.

Registration and Marking Requirements for Small Unmanned Aircraft. RIN 2120-AK82. United States Department of Transportation. In force as interim rule between 16 December 2015 and 1 December 2018, in force as final rule since then.

Regulatory Article 1600: Remotely Piloted Air Systems (RPAS). United Kingdom Ministry of Defence and Military Aviation Authority. Issued and in force since 19 January 2015.

Case Law

Alton & Sangamon Railroad Company v. Baugh (1852). Illinois Supreme Court. In *Illinois Reports*, Vol. 14, p. 210 *et seq*.

Bragdon v. Abbott (1998). United States Supreme Court. In *United States Reports*, Vol. 524, p. 624 *et seq*.

Davis v. Davis (1992). Supreme Court of Tennessee. In *South Western Reporter*, Vol. 842, p. 588 *et seq*.

Hemingway v. Fernandes (1842). Chancery Division. In *English Reports*, Vol. 60, p. 89 *et seq*.

National Union Electric Corporation v. Matsushita Electric Industrial Company (1980). United States District Court for the Eastern District of Pennsylvania. In *Federal Supplement*, Vol. 494, p. 1257 *et seq*.

Sutton v. United Air Lines (1999). United States Supreme Court. In *United States Reports*, Vol. 527, p. 471 *et seq*.

Other Sources

Air Pilot's Manuals. Pooley's (undated). https://pooleysapp.com/.

Air transport, passengers carried. The World Bank (updated yearly). https://bit.ly/2GFulmn.

Airbus A320neo. Airbus (undated). https://bit.ly/3bhbbOr.

Airbus' Skyways drone trials world's first shore-to-ship deliveries. Airbus Newsroom (15 March 2019). https://bit.ly/3btmaEc.

Aircraft Cost Evaluator. Conklin & de Decker (updated regularly). https://bit.ly/34lHOYN.

American Airlines Income Statement. Reuters (updated regularly). https://reut.rs/3crNLpK.

ASD Position Paper: The Unmanned Aircraft Systems Traffic Management (UTM) Regulation. Aerospace and Defence Industries Association of Europe (21 February 2020). https://bit.ly/2AEmeDO.

Best Drones for Sale. MyFirstDrone (undated). https://bit.ly/34rNm4h.

BF-Lento: Private Pilot Training. BF-Lento (undated). https://bit.ly/34DmC0P.

Cessna Skyhawk. Textron Aviation (undated). https://bit.ly/36r7PbY.

Commercial aircraft fleet by age of aircraft. Eurostat (undated). https://bit.ly/3csggDG.

DJI Adds Airplane and Helicopter Detectors to New Consumer Drones. DJI Newsroom (22 May 2019). https://bit.ly/2yp5P4Q.

DJI Mavic 2. DJI (undated). https://www.dji.com/fi/mavic-2.

DRONEII Drone Market Report 2019–2014. Drone Industry Insights (27 March 2019). https://bit.ly/34lGllf.

Drones 101. Business Insider (April 2018). https://bit.ly/3dWOqAg.

EHang 216 Autonomous Aerial Vehicle (undated). Aerospace Technology. https://bit.ly/2wRvNxK.

EHang Launches Guangzhou as Its First Global Citywide Urban Air Mobility Pilot City. EHang (6 August 2019). http://www.ehang.com/news/526.html.

European Cockpit Association Specific Operations Risk Assessment (SORA) Position Paper. European Cockpit Association (28 January 2019). https://bit.ly/2AxscpQ.

Freefly Alta 8. Freefly Store (undated). https://bit.ly/3exgo6s.

JARUS CS-UAS: Recommendations for Certification Specification for Unmanned Aircraft Systems, edition 1.0. JARUS (2019).

JARUS Guidelines on Specific Operations Risk Assessment (SORA), edition 2.0. JARUS (2019).

JARUS Recommendation for Remote Pilot Competency (RPS) for UAS Operations in Category A (Open) and Category B (Specific), edition 1.0. JARUS (2019).

JARUS: Who We Are. JARUS (undated). http://jarus-rpas.org/who-we-are.

Oxford English Dictionary Online. Oxford University Press (updated regularly). http://oed.com.
Starr Bumble Bee. Prima Air & Space Museum (undated). https://bit.ly/3ldpkk5.
The Vanguard. Airborne Drones (undated). https://bit.ly/36spqQR.
Uavionix Ping200S. Uavionix (undated). https://bit.ly/2SwG1dP.
UK Registered Aircraft as at 1st January Each Year. UK CAA (updated yearly). https://bit.ly/2XFvJfr.
UK VEH02: Licensed cars. UK Government (updated regularly). https://bit.ly/34n0iIy.