SPACE TRAVEL, LAW & BLACK HOLES

An analysis of the liability issues involved in commercial space transportation

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Abstract

This thesis reviews the commercial space travel market and examines the space law related thereto. An examination of the lacunae in the international space law is conducted with the conclusion that the international space law is lacking as the space travel industry develops. The liability regime, in particular, is missing certain aspects that will help the industry to blast off into profitability. The cost of commercial space travel is currently very high. It is proposed that a limitation on liability, such as those limitations imposed on the aviation industry at its infancy, will enable space travel operators and their insurers to determine a more precise maximum probable loss. This, in turn, will give certainty to insurers and market capacity will increase, thereby lowering the costs to the space travel operator, who will pass those savings onto the consumer. These savings will lower costs and allow more access to the space travel industry, which will spur investment and growth, and allow the industry to reach its ambitious goals of intercontinental rocket transport and space hotels in the coming years.

Cette thèse examine le marché du voyage de l'espace commercial et examine le droit de l'espace s'y rapportant. Un examen des lacunes dans le droit international de l'espace est réalisé avec la conclusion que le droit international de l'espace manque lorsque l'industrie se développe. Le régime de responsabilité, en particulier, est manquant certains aspects qui aideront l'industrie à décoller vers la rentabilité. Le coût de voyage de l'espace commercial est actuellement très élevé. Il est proposé qu'une limitation de responsabilité, tels que les limitations imposées à l'industrie de l'aviation, permettront aux opérateurs de programmes du voyage de l'espace commercial et leurs assureurs pour déterminer une perte probable maximale plus précis. Ceci donnera la certitude aux assureurs et la capacité du marché augmentera, réduisant ainsi les coûts pour les operateurs, et par conséquent, les participants. Ces économies vont réduire les coûts et permettra un meilleur accès à l'industrie du voyage de l'espace commercial, ce qui stimulera l'investissement et la croissance, et permettra a l'industrie d'atteindre ses objectifs ambitieux de transport de fusée intercontinentaux et les hôtels en espace dans les années à venir.

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Chapter One: Introduction

> "For I dipped into the future, far as human eyes could see. Saw the vision of the world and all the wonder that would be"
> ~Tennyson

The way we think about outer space is changing and growing. Outer space was once a vast collection of constellations and planets, to be explored only by the most intelligent and accomplished members of the scientific community who were chosen to be 'envoys of mankind'[1] by their nation's government. Now, Lightsabers and Starships stimulate imaginations of what could be "out there" in the universe, and insatiable curiosity encourages demand and growth for space technologies. In addition to stirring curiosity, outer space is a platform for advanced technology, science, research, and astronomy. New space technologies and transportation systems will bring tourists to the edge of the galaxy, and ordinary persons will be able to explore and use outer space as the province of all mankind.[2] Children used to look up at the sky and dream of becoming an astronaut one day. Now, children (and adults!) can look up to the sky and envision going to space for a vacation, and potentially take "space camp" to the next level.

An increase in business and travel opportunities has opened up the world to global citizens. We can travel places and see things on earth that our ancestors could only dream or read about. People are working, traveling, and studying abroad. With the advancement in technologies like email and Skype, society is more connected than ever before. Connections between people who live tens of thousands of miles apart can be developed and fostered, and can turn into deep, long lasting relationships. It follows that the ability to communicate and develop relationships with people so far away also develops an urge to see the locations where those people live their lives, and visit them whenever possible. An insatiable thirst for travel, adventures and new experiences guarantees that the tourism

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[1] *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*, 27 January 1967, 610 UNTS 205 art V (entered into force 10 October 1967) [*Outer Space Treaty*].
[2] *Outer Space Treaty,* art I.

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industry will never cease to exist. While cities or hotels may have fluctuating periods, there will undoubtedly be people around the world who will continue to travel.

"Travel" could mean taking a drive in a car to the next town over for a business meeting, taking a train across provincial borders to meet family for a holiday, cruising through the Caribbean for a week exploring archipelagos, or taking a cross-continental flight for the weekend to experience what authentic Chinese or Italian food tastes like. Prior to the success of the aviation industry, the only options for travel were by land or by sea. But with aviation, people can go more places, more quickly than ever before, and can stay longer because of diminished travel times. The advent of commercial space transportation has the potential to diminish that travel time even further. Time has become a constant problem, whereby there is never enough time to complete everything one wants to do. To be able to give the gift of time by reducing travel time is worth a great deal to many types of people, including business people, families, friends, and colleagues. New technologies and modes of aerospace transportation could allow the gift of time to be realized in the not-so-distant future.

The advent of new discoveries and opportunities in space travel "opens up an exciting opportunity to develop an adequate system of legal regulation to deal with these activities". [3] Researchers have been working tirelessly since the dawn of the space race to discover new and different ways of benefitting from space. However, the legal framework, or "Space Law", is not current and is not reflective of a commercial industry. This is due, in part, because "[t]he existing international legal regimes covering air and space activities are not well suited to large-scale commercial access to space, largely because they were developed at a time when such activities were not a principal consideration in the mind of the drafters".[4] Furthermore, the cost involved in going to space at this point is in the hundreds of thousands of dollars, this is due in part to the risk

[3] Tanja Masson-Zwaan & Steven Freeland, "Between Heaven and Earth: The Legal Challenges of Human Space Travel" (2010) 66 *Acta Astronautica* 1597 at 1597.
[4] *Ibid*.

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involved with space travel. Finding a way to lower the cost of insurance for these risky ventures could decrease the cost of space travel as a whole.

The time has come for the international community to look up to outer space through the eyes of a child and envision dramatic examples of aliens, Lightsabers and teleportation machines. Recalling the principles of imagination and curiosity, it is time to start thinking about what needs to be done on earth to make the exploration of space for all of mankind a possibility in our lifetime.

This thesis is focused on space travel; and in particular, the space law that applies to traveling to outer space. Space travel encompasses many space activities, and has wide application. The first step in this analysis is to explore the scope of activities to which space law applies. For the purposes of this analysis, "Space Travel" is defined broadly and refers to one or more space activities, which may include: Space Tourism, Space Transportation, Space Habitats, Space Hotels, and/or Space Shuttles. "Space Tourism" is undertaking one or more space activities for the purpose of pleasure or leisure where the main purpose is to experience outer space, and could include a stay in a space hotel.

A "Space Hotel" is a space object[5] wherein a human may sustain life for an extended period of time. For the purposes of this analysis, "Space Hotel" or "Space Habitat" may be used interchangeably, as humans may also sustain life for an extended period of time in a space habitat. The difference between the two is the purpose of the human being using the space object. If the human is there to experience space for space tourism purposes, the space object is a space hotel. If the purpose of the visit is for research, experimental, or technical purposes, the space object is a space habitat. The International Space Station ("ISS") is a space habitat, for example. However, when space tourists visit the ISS, it takes on the character of a space hotel. Thus, since space objects may have dual purposes, the terms are used interchangeably. To get to the ISS and other

[5] A "space object" is any object designed for use in outer space, and includes space vehicles, space hotels or habitats, and satellites.

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space hotels, space tourists and astronauts fly in a "Space Shuttle", which is a reusable space vehicle that carries passengers or cargo between a terrestrial location and outer space, and would generally be a one-way flight, either to, or from, outer space.

In this thesis, space tourists and astronauts are defined separately. "Space Tourists" are individuals who engage in space activities for space tourism purposes. "Astronauts" are those that are engage in space activities by actually conducting the space activity itself. The pilot of a space vehicle, for example, is an astronaut, as well as those persons who fall within the "typical" definition of astronaut,[6] such as a person appointed by a State to carry on activities for the benefit of that State (and all mankind, for that matter, which will be discussed below). Some commercial companies market that space tourists will immediately become astronauts upon atmospheric entry. Webster's defines "astronaut" as "one trained to make flights into outer space". This author considers that the key word in that definition is "trained". Notwithstanding the fact that space tourists will be trained to survive their brief mission to space, such training is comparable to that which a passenger on an aircraft or a guest on a cruise ship would receive. Space tourists will be trained on what to do in an emergency, but they are not specifically trained to carry out the space activity. An aircraft passenger, for example, is not trained to fly the aircraft, nor a cruise ship passenger trained to steer the ship. This author considers that those trained to carry out space activities are astronauts, notwithstanding if they carry out space activities for commercial, governmental, or private purposes. Furthermore, an astronaut is a title that attaches for life, thus an astronaut engaging in space tourism would be both a space tourist and an astronaut, but the terms are not mutually exclusive.

"Space Transportation" refers to the carrying of passengers or cargo from one terrestrial location to another terrestrial location, which may be the point of origin or another location. This definition encompasses many forms of transportation systems, including suborbital spaceflights, intercontinental, or "point-to-point", spaceflights, and

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[6] *Webster's New World Dictionary and Thesaurus*, 2nd ed, *sub verdo* "astronaut".

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also includes space shuttles. "Commercial Space Transportation" is space transportation for a commercial or private purpose. It is an emerging industry which is changing and growing with new technological advances. Freeland notes that

> [t]he public perception of commercial space travel has undergone a significant change over the past decade – from mere fantasy to possible reality – mirroring an evolutionary process that emerged in the first half of the 20th century, which ultimately led to a global commercial air travel industry.[7]

Freeland goes on to suggest that "[a]s technology is developed to make widespread space tourism a reality, it is incumbent on the law itself to develop in order to meet the demands for proper regulation of such activities".[8]

"Space Law", for the purposes of this analysis, is the law that applies[9] to space travel and is used in a general way to describe any and all laws that apply to outer space or space activities. Space law refers to the laws adopted by the international community; and domestic legislation that has been put in place by individual states. In this thesis, the term "Space Law" is used both collectively and individually.

The first space law was created by the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS). UNCOPUOS established five multilateral treaties with the purpose "to establish fundamental legal principles to govern the space activities of the States".[10] The space law treaties are focused mainly on the general principles surrounding the use and exploration of outer space,[11] the rescue and return of astronauts and other space objects,[12] liability that could be incurred for damage caused by space

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[7] Steven Freeland, "Fly Me to the Moon: How Will International Law Cope with Commercial Space Tourism?" (2010) 11 Melb J Int'l Rev 1 at 3.
[8] *Ibid,* at 4.
[9] The "application" of space law in certain situations is debatable, which will be discussed below.
[10] Ram Jakhu, "Legal Issues Relating to the Global Public Interest in Outer Space" (2006) 32 J Space L 31 at 107.
[11] *Outer Space Treaty*.
[12] *Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space*, 22 April 1968, 672 UNTS 119 (entered into force 3 December 1968) [*Rescue Agreement*].

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objects,[13] registration requirements for objects launched into outer space,[14] and principles governing the activities of States in the exploration and use of outer space, including the moon and other celestial bodies.[15] States have also put national or domestic space law into place to supplement and/or implement the international space law. This analysis will begin with an analysis of the space law applicable (or not applicable, as the case may be) to commercial space travel.

The nature and extent of space travel has changed since the first space laws were created. Commercial uses of outer space were not anticipated by UNCOPUOS at the time of drafting the international treaties, and the treaties have not been significantly amended since their adoption. When the treaties were created, "it had certainly not been anticipated that humankind would engage in widespread commercial space tourism and, as a result, these treaties do not deal with such activities in any specific detail".[16] Therefore, specific consideration of the needs of the commercial space travel industry is mostly excluded from international space law. Therefore, there is ambiguity in the terms and application of space law when it comes to space travel. It has been noted that "regulators lack the knowledge and experience of regulating experimental vehicles that are yet to be in existence. In other words, the regulators do not know, and cannot know, what it is that they are to regulate".[17] Accordingly, a thorough analysis of the types of space travel that are to be regulated by space law is appropriate and will be undertaken in the course of this analysis.

With the development of any industry, there are a myriad of legal issues and questions that must be answered. Specifically, liability for commercial activities in space,

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[13] *Convention on International Liability for Damage Caused by Space Objects*, 29 Mar 1972, 961 UNTS 187 (entered into force 1 September 1972) [*Liability Convention*].
[14] *Convention on Registration of Objects Launched into Outer Space*, 14 January 1975, 1023 UNTS 15 (entered into force 15 September 1976) [*Registration Convention*].
[15] *Outer Space Treaty*
[16] *Supra* note 7 at 6.
[17] Melanie Walker, "Suborbital Space Tourism Flights: An Overview of Some Regulatory Issues at the Interface of Air and Space Law" (2007) 33 J Space L 375 at 380 [footnotes omitted].

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including space travel, is undefined. It is undisputed that space activities are expensive and risky. It follows, unfortunately, that there will be an accident, and a party will incur liability for damage caused by a space object, launch, or activity. Insurance can help to guard against the possibility that an accident could financially cripple a corporation, as they start-up at the infancy of a new industry. However, insurance for a high-risk, expensive activity that takes place in a volatile atmospheric and legal environment is not cheap. Insurance premiums get passed on to the consumers, which is why the current price tag for a suborbital flight is US$250,000.00, up front, for a flight of which only about fifteen minutes takes place in outer space.[18] The aviation industry faced a similar problem at the dawn of the golden age of flight, and introduced an internationally agreed-upon cap on liability, that effectively allowed airlines to determine a more precise figure of loss that could be used to determine the amount of insurance required per flight. This provided certainty to insurers and lower costs to carriers. A cap on liability would provide similar benefits for space travel; providing financial certainty by defining a maximum probable loss, lowering prices and accessibility for consumers, and allowing the space travel industry to blast off into profitability.

[18] Virgin Galactic, "Ready to Become an Astronaut?" online: Virgin Galactic <http://www.virgingalactic.com/human-spaceflight/fly-with-us/>.

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Chapter Two: International Space Law

Since the launch of the Russian satellite "Sputnik 1" in 1957, the exploration and use of outer space has changed drastically. Initially, only States participated in space activities. The use of outer space has now evolved into a commercial industry. What was once an industry that cost governments billions of dollars now has the potential to evolve into a billion-dollar profit-making scheme for private corporations. The evolution from public to private use and exploration was not foreseen when the major international space treaties, which form the governing standard for the exploration and use of outer space, were drafted. The treaties were established in the spirit of cooperation,[19] anticipating mutual benefit[20] to signatories and all terrestrial States. The treaties have never been significantly amended or changed to reflect the changing industry and presence of commercial entities in space.

While space law has been in existence for upwards of fifty years, commercial space transportation is an emerging market that does not currently have a comprehensive international legal regime that is sufficient to cover the field of projected use. There are a growing number of black holes or "*lacunae*"[21] in the legal framework of space law as the way States and the public use outer space changes over time. It is thus necessary to analyze the applicable international and domestic legal frameworks and ensure that the laws are accurately reflecting the current and projected exploration and use of outer space. Issues arise particularly in relation to liability and the uncertainty with respect to who might be responsible for a loss or damage that occurs in outer space, especially when there are commercial or private entities involved. With the emerging space travel markets in mind, the realization has to be made that the multilateral treaties created by UNCOPUOS at the dawn of the space race are not all encompassing. Freeland observed

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[19] *Outer Space Treaty*, Preamble.
[20] *Outer Space Treaty*, Preamble
[21] Webster's defines "Lacuna" as "a blank space; especially a mission portion in a text, etc." *Webster's New World Dictionary and Thesaurus*, 2nd ed, *sub verdo* "lacuna".

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in 2011 that "the hard law principles that do exist may not be sufficient even for present purposes, let alone for the coming decades".[22] UNCOPUOS has adopted further resolutions since 2011, as will be discussed below, but consensus is yet to be achieved on many important and pressing questions.

International space law is found in Treaties and Conventions, principles of Customary International Law, General Principles of Law and Court Judgments and *opinio juris*.[23] The International Court of Justice ("ICJ") is the "principal judicial organ of the United Nations";[24] and the venue where States have the opportunity to seek the Court's determination of issues in dispute between States.[25]

Historically, the laws of outer space were developed by multilateral treaties at the United Nations, primarily though the Committee on Peaceful Uses of Outer Space. UNCOPUOS was developed in 1958 and is mandated to address legal problems arising

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[22] Steven Freeland, "For Better or for Worse? The Use of 'Soft Law' Within the International Legal Regulation of Outer Space" (2011) XXXVI Ann Air & Space L 409 at 442.

[23] Article 38 of the Statute of the International Court of Justice reads:

> 1. The Court, whose function is to decide in accordance with international law such disputes as are submitted to it, shall apply:
> a. international conventions, whether general or particular, establishing rules expressly recognized by the contesting states;
> b. international custom, as evidence of a general practice accepted as law;
> c. the general principles of law recognized by civilized nations;
> d. subject to the provisions of Article 59, judicial decisions and the teachings of the most highly qualified publicists of the various nations, as subsidiary means for the determination of rules of law.
> 2. This provision shall not prejudice the power of the Court to decide a case *ex aequo et bono*, if the parties agree thereto:

Statute of the International Court of Justice 26 June 1945, 59 Stat 1031 art 38 (entered into force 24 October 1945) [*ICJ Statute*].

[24] *ICJ Statute*, art 1.

[25] The jurisdiction of the ICJ, *inter alia*, is laid out in Article 36(1) of the *ICJ Statute*:

> The jurisdiction of the Court comprises all cases which the parties refer to it and all matters specially provided for in the Charter of the United Nations or in treaties and conventions in force:

ICJ Statute, art 36(1).

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from the exploration and use of outer space by seeking consensus from States. Faced with the emergence of an unknown and untouched environment, UNCOPUOS developed five[26] main treaties between 1961 and 1979 that "creat[e] the fundamental principles of the international regulatory regime governing Space activities".[27] Since the time, the General Assembly has adopted resolutions embodying new principles for the exploration and use of outer space. The principles "have largely been considered as constituting 'soft law', although a number of specific provisions may now represent customary international law".[28]

Customary international law can develop in the exploration and use of outer space and, due to the nature and frequency of space activities, unwritten laws of outer space may emerge quickly as customary international law. When it comes to outer space, the emergence of customary international law can be "instant". This is in contrast to the typical ways by which customary international law is established, which could take one hundred years or more of continued endorsement by States. The International Court of Justice has stated that "it might be that, even without the passage of any considerable period of time, a very widespread and representative participation in the convention might suffice of itself, provided it included that of States whose interests were specially affected."[29] Customary international law is sometimes codified in treaties, although it need not be codified in order to be a principle of law that should be adhered to. With respect to space law, the foundational customary international law that has emerged are

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[26] *Outer Space Treaty; Rescue Agreement; Liability Convention; Registration Agreement; Agreement Governing the Activities of States on the Moon and Other Celestial Bodies*, 18 December 1979, 610 UNTS 23002 (entered into force 11 July 1984) [*Moon Agreement*].

[27] Ram Jakhu and Yaw Nyampong, "International Regulation of Emerging Modes of Space Transportation" in Joseph Pelton and Ram Jakhu, eds, *Space Safety Regulations and Standards* (Burlington, MA: Elsevier Ltd, 2010) 215 at 220.

[28] *Supra* note 7 at 7 citing generally Ricky J Lee and Steven R Freeland, "The Crystallisation of General Assembly Space Declarations into Customary International Law" (2004) 46 Proceedings of the Colloquium on the Law of Outer Space 122.

[29] *North Sea Continental Shelf Cases (Federal Republic of Germany/Denmark: Federal Republic of Germany/Netherlands*), [1969] ICJ Rep 4 at 43.

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the "common interest", "freedom", and "non-appropriation" principles, which have been codified in the *Outer Space Treaty*.[30]

Demarcation of Air Space and Outer Space

At the most basic level, the question arises as to where space law applies. The respective laws that govern air space and outer space are "diametrically opposed".[31] Air law respects a States' absolute sovereignty in the air space above their territory and their right to regulate as they see fit (subject to international agreements); whereas space law dictates that outer space is not subject to sovereignty or any claims of appropriation, whatsoever.

With respect to air law, the principle of complete and exclusive sovereignty over a State's airspace is customary international law[32] that has been codified in the *Convention on International Civil Aviation,* or the *"Chicago Convention"*.[33] The *Chicago Convention* is the Constitution of the International Civil Aviation Organization ("ICAO"), which is the specialized agency of the United Nations that is responsible for international air transport. Therefore, while a State has the absolute right to legislate and regulate the air space above their territory, this right ends where outer space begins.

A question asked by every academic when analysing this area of law is: where does outer space begin? The problem is that there is no clear definition of where air space ends and outer space begins. Without the answer to this question, it is difficult to ascertain the precise application of the law. A thorough review of the analysis of air and space law reveals that the only consensus that has been reached, is that an answer to this

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[30] *Outer Space Treaty*, arts I & II.
[31] *Supra* note 7 at 10.
[32] "The Principle of respect for territorial sovereignty is also directly infringed by the unauthorized overflight of a State's territory by aircraft belonging to or under the control of the government of another State": *Military and Paramilitary Activities in and against Nicaragua (Nicaragua v US) (Merits)* [1986] ICJ Rep 14 at 128.
[33] *Convention on International Civil Aviation*, 7 December 1944, 15 UNTS 295, art 1 (entered into force 4 April 1947)[*Chicago Convention*].

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question is necessary for further legal clarity. Therefore, at this stage in time an analysis of the international law that applies to outer space must be intertwined with an analysis of air law, as either of these bodies of law could apply at different points of a space object's flight. While a State could simply choose to define outer space as they see fit, a universal solution is required. Freeland contends "that the applicability of different laws would represent an unsatisfactory and impractical solution and actually lead to greater uncertainty in the absence of a clear defining point for the 'boundary' between air space and outer space".[34]

The two main theories being explored by the international community are the "functional" theory and the "spatial" theory.

Functional Theory

The functional theory dictates that the law of a space object is regulated by the purpose or function of that object. This means that if a space object "blasts off" and is propelled through the airspace, the law that applies, at all times, is space law. Using this theory, all space objects would be subject to "space law", regardless of their placement within a sovereign area of a State.

It might seem straightforward at the outset to contend that a space vehicle is subject to space law at all times, but it is not as clear as one may think when considering the technologies that are advancing. Virgin Galactic and Swiss Space Systems, among others,[35] use "air launch" methods, whereby an aircraft carries a space vehicle to altitude where the space vehicle is launched in mid-air. The aircraft is subject to aviation law, while the space vehicle is subject to space law. The suggestion has been made that

> the most appropriate way of regulating such flights under existing legal principles would be to apply air law to the 'combined' vehicle (that is, before the launch), and then apply space law to

[34] *Supra* note 7 at 13.
[35] Commercial space travel systems will be discussed further in chapter four.

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> [the space vehicle] from the moment it is launched until its return to Earth.[36]

However, while this solution may seem "pragmatic", it is unsatisfactory because the legal regime that applies in the event of an accident, namely air law or space law, is dependent on the precise timing of the accident. Thus, "this uncertainty further highlights the need for a comprehensive set of rules, based on existing space law principles, to cover all phases of a flight".[37]

Spatial Theory

The spatial theory dictates that air law applies up until the space object reaches a specific point, at which time the applicable law switches from air law to space law. Australia appears to have codified the spatial theory into their domestic law and regulated that outer space, and accordingly the application of space law, begins once a space object reaches 100km. To date, Australia is the only State to codify the demarcation of air space and outer space. The rest of the international community has yet to achieve consensus, despite being on the agenda of UNCOPUOS since its inception. The inference is that States are cautious in determining the demarcation point, because it results in the loss of sovereignty from that point upwards.

In 2008, the Australian definition of outer space[38] gained steam in a high-profile context[39] with the "Draft Treaty on the Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force against Outer Space Objects" ("Draft Treaty"),[40] a draft treaty which was introduced by the Russian Federation and China, two major space-faring nations. Article I(a) of the Draft Treaty read:

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[36] *Supra* note 7 at 14.
[37] *Ibid.*
[38] *Space Activities Act 1998* (Cth), s 8.
[39] *Supra* note 7 at 12.
[40] UN Conference on Disarmament, *Draft Treaty on Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force against Outer Space Objects*, UN Doc CD/1839 (29 February 2008) [*Draft Treaty*].

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> For the purposes of this Treaty:
> (a) The term "outer space" means the space above the Earth in excess of 100 km above sea level;[41]

The presentation of the Draft Treaty represented a radical shift. Russia, China, and the US had previously stifled attempts to formalize the demarcation of air space and outer space.[42] The US and other allies have since objected to the necessity of establishing a boundary line, noting that there have been no problems caused up until now.[43] However, the legal regimes governing air space and outer space, respectively, are so categorically opposed that it is indispensable for States to know which law applies, and where.[44]

The Outer Space Treaty

The 'Charter' of International space law is the *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*, or the "*Outer Space Treaty*".[45] The *Outer Space Treaty* "is widely considered to be the constitution of outer space and the foundation of the international legal regime governing all space activities".[46] Eminent scholars note that "[t]he global public interest in outer space was recognized by the international community with the conclusion of the 1967 Outer Space Treaty".[47]

On the historical occasion of the adoption of the *Outer Space Treaty*, the Italian delegate to UNCOPUOS, Mr. Vinci, delivered a statement to the Twenty-first session of the General Assembly, stating:

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[41] *Draft Treaty,* art I(a).
[42] *Supra* note 7 at 13.
[43] *Supra* note 10 at 93.
[44] *Ibid.*
[45] P.P.C. Haanappel, *The Law and Policy of Air Space and Outer Space: A Comparative Approach* (The Hague, Netherlands: Kluwer Law International, 2003) at 55.
[46] *Supra* note 10 at 31.
[47] *Ibid.*

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> For the first time in the history of mankind, all countries, and in first instance the two world Powers of the day, are not searching for new territorial conquests or for the expansion of their sovereign rights. On the contrary, they aim only at scientific and technological conquests in the new continents of outer space, which become not the province of single Powers, but the province of mankind as a whole. For the first time in the wake of our first space explorations, national, religious and ideological concepts are put aside, and in their place the ideas of peace and the unity of all men, regardless of their religion, creed or colour, are solemnly affirmed.[48]

The conclusion of the *Outer Space Treaty* was a remarkably historical occasion and caused celebration for what was to come ahead. However, the delegate of France, Mr. Seydoux, aptly remarked that the *Outer Space Treaty* "is only, as it were, the first chapter of the law of outer space on which much still remains to be done".[49] The Austrian delegate, Mr. Waldheim, "stated that the scientific and technical achievements in outer space must be matched by legal and political agreements".[50] These two comments may imply that the *Outer Space Treaty* was lacking some key aspects at the outset that may continue to apply today. The *Outer Space Treaty* and existing space law presents a good foundation upon which to build new space law, but additions are nonetheless required to get the legal regime up to speed with the emergence of new forms of aerospace transportation and technologies.

The States Parties to UNCOPUOS were "*[inspired]* by the great prospects opening up before mankind as a result of man's entry into outer space".[51] An opportunity to cooperate and "*[recognize]* the common interest of all mankind in the progress of the exploration and use of outer space for peaceful purposes",[52] regardless of the economic or

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[48] Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), United Nations treaties and principles on outer space, A/CONF.184, UNOOSA, 1999, UN Doc A/AC.105/722, at p 69 [*UNISPACE III*].
[49] *Ibid.*
[50] *Ibid*, at p 70.
[51] *Outer Space Treaty*, Preamble.
[52] *Outer Space Treaty*, Preamble.

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scientific resources,[53] presented itself. A similar situation emerges with the advent of commercial human spaceflight. There are great prospects opening up before mankind as a result of the emergence of this new way of exploring space. Engaging in commercial human spaceflight contributes to understanding space, which advances mankind's awareness about space.

The States Parties agreed that outer space is the "province of mankind" and "shall be free for exploration and use by all States without discrimination of any kind".[54] The "principle of cooperation and mutual assistance" guides the activities of States Parties in the exploration and use of outer space, and all activities in outer space must be conducted "with due regard to the corresponding interests of all other States Parties".[55] To this end, the States Parties' agreed that outer space "is not subject to national appropriation" by any means.[56] "States Parties to the [*Outer Space Treaty*] shall bear international responsibility for national activities in outer space",[57] which creates liability for States based on the space activities of their nationals. This State liability will be discussed in-depth in the next chapter. At the time of drafting, the only persons included in the term 'nationals' would have been citizens of a State who were under the employment or direction of the State. The lay of the land significantly changes with non-governmental entities in space, and the continuing responsibility on States, and "international liability" for any damage to a third party, whether in air space or in outer space,[58] could burden on the State as the number of space activities increases. The *Outer Space Treaty* also requires States to retain "jurisdiction and control" over their registered space objects.[59] Further, "[t]he activities of non governmental entities in outer space shall require authorization and continuous supervision by the appropriate State Party".[60] However, the

[53] *Outer Space Treaty*, Preamble.
[54] *Outer Space Treaty*, art I.
[55] *Outer Space Treaty*, art IX.
[56] *Outer Space Treaty*, art II.
[57] *Outer Space Treaty*, art VI.
[58] *Outer Space Treaty*, art VII.
[59] *Outer Space Treaty*, art VIII.
[60] *Outer Space Treaty*, art VI.

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appropriate State Party is not always clear. Haanappel notes that "[who] the "appropriate State Party" is, is not always easy to say: it is not necessarily the same state as the launching State or the State of registry".[61] Lack of clarity as space activities increase could be devastating to the resources of States.

Registration Convention

The *Registration Convention* establishes a two-fold system of mandatory reporting, which requires national or domestic registration,[62] and United Nations registration.[63] Procedures for establishing national or domestic registry are determined at the prerogative of the State. United Nations registration requires that States furnish information concerning space objects carried on their register as soon as practicable to the UN Secretary General. The information that each State of Registry shall furnish to the Secretary General, "as soon as practicable", concerning each space object carried on its registry is specified in the *Registration Convention*.[64] States must provide information about designators or registration numbers and supply the Secretary General "from time to time" with additional information. States must also notify the Secretary General, "to the greatest extent feasible and as soon as practicable," of previously reported satellites that are no longer in Earth orbit.[65] The Secretary General maintains this information in a United Nations register.[66]

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[61] *Supra* note 10 at 57.
[62] The requirement for a national register is set out in Article II of the *Registration Convention*, which reads, in part:

1. When a space object is launched into Earth orbit or beyond, the launching State shall register the space object by means of an entry in an appropriate registry which it shall maintain. Each launching State shall inform the Secretary-General of the United Nations of the establishment of such a registry.
2. Where there are two or more launching States in respect of any such space object, they shall jointly determine which one of them shall register the object in accordance with paragraph 1 of this article…: *Registration Convention*, art II.

[63] *Registration Convention*, art III.
[64] *Registration Convention*, art IV.
[65] *Registration Convention,* arts IV & V.
[66] *Registration Convention,* art III.

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At first it seems quite clear that the registration of commercial vehicles will help with their regulation. However, there is a significant flaw in the *Registration Convention* that excludes certain types of space vehicles from its terms. Article II of the *Registration Convention* provides that a space object shall be registered "when a space object is launched into Earth orbit or beyond".[67] Technological and market advances in the commercial space transportation industry are assisting to develop new forms of commercial space transportation, however not all (and not many) of the commercial space transportation services that are in the development stages will enter Earth orbit. The model of Virgin Galactic, for example, is a suborbital space flight system,[68] and the terms of the *Registration Convention* "[do] not cover commercial space vehicles rising only to suborbital space".[69] This could have serious implications for air and space traffic management, as well as the obligation on a State to continuously supervise the activities of commercial entities "in outer space".[70]

Moon Agreement

The *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies*,[71] or the "*Moon Agreement*" attempts, *inter alia*, to establish a regime for the use of resources on the Moon, much like the international regime governing the use of resources on the high seas.[72] Negotiations and discussions surrounding the provisions of the *Moon Agreement* began in 1969 and it took ten years before States were able to come to agreement. However, even after the lengthy negotiation period, the *Moon Agreement* has the lowest rate of ratification, with only sixteen States ratifying or acceding to it. It has been suggested that the reason for this is due, in part, to the fact that

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[67] *Registration Convention*, art II.
[68] Virgin Galactic's space vehicles will be further explored in Chapter four.
[69] Charles W. Stotler, "International and U.S. National Laws Affecting Commercial Space Tourism: How ITAR Trips the Balance Struck Between the International Law and the CLSAA" (2007) 33 J Space L 245 at 246.
[70] *Outer Space Treaty*, art VI.
[71] *Moon Agreement*.
[72] See generally: *United Nations Convention on the Law of the Sea*, 10 December 1982, 1833 UNTS 3; 21 ILM 1261 (entered into force 16 November 1994).

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the principle of the common heritage of mankind plays an important role in the *Moon Agreement*, and the international community is now finding that that principle is becoming more unacceptable to the international community at large.[73] Article 11 of the *Moon Agreement* provides that "[t]he Moon and its natural resources are the common heritage of mankind"[74] and that "[t]he Moon is not subject to national appropriation by any claims of sovereignty, by means of use or occupation, or by any other means".[75]

At the dawn of the space race, no one knew what resources were "out there". On the one hand, States wanted an even footing so that the exploration of use of outer space would be for the benefit of mankind. However, as new technologies develop and more is learnt about the resources in outer space, States are beginning to lean towards the private or commercial use and exploitation of those resources. Contrary to private exploitation, the *Moon Agreement* sets out that:

> Neither the surface nor the subsurface of the Moon, nor any part thereof or natural resources in place, shall become property of any State, international intergovernmental or non-governmental organization, national organization, or non-governmental entity or of any natural person. The placement of personnel, space vehicles, equipment, facilities, stations and installations on or below the surface of the Moon, including structures connected with its surface or subsurface, shall not create a right or ownership over the surface or the subsurface of the Moon or any areas thereof…[76]

Essentially, this portion of the *Moon Agreement* notes that no State can claim any portion of the Moon. So, when Neil Armstrong placed the American Flag on the Moon in 1969, the United States did not obtain ownership rights over the Moon through the terrestrial principle of "*terra nullius*" or "finders keepers". Similarly, the 5,000,000 people who have purchased "Moon Land" from the "Earth's Oldest, Most Recognized

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[73] *Supra* note 45at 60.
[74] *Moon Agreement*, art 11(1).
[75] *Moon Agreement*, art 11(2).
[76] *Moon Agreement*, art 11(3).

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Celestial Real Estate Agency",[77] run by Dr. Dennis Hope, the self-proclaimed "President of the Galactic Government",[78] will be disappointed to know that they have purchased very expensive pieces of paper, not a "deed" to a portion of the Moon. Dr. Hope claims that because the *Moon Agreement* and the *Outer Space Treaty* prevent States from claiming ownership, it does not preclude individual owners of the Moon and other celestial bodies.[79] This presents an interesting argument which should be clarified through further space law – whether or not an individual can appropriate portions of the moon or celestial bodies.

The "right to exploration and use of the Moon" is "without discrimination of any kind, on the basis of equality and in accordance with international law".[80] At the time the *Moon Agreement* was drafted, it was too early to make comprehensive regulations outlining how States should address the issue of resource-exploitation in space when that eventuality came to light. However, the States Parties were in agreement that the issue would need to be addressed at some point in the future and undertook to develop an international regime[81] at such time that the exploitation of resources is about to become

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[77] Lunar Embassy, "About Us" online: LunarLand.com <http://www.lunarland.org/about-us>.
[78] Lunar Embassy, "Who is Dr. Dennis Hope?" online: LunarLand.com <http://www.lunarland.org/dr-dennins-hope>.
[79] Lunar Embassy, "Who is Dr. Dennis Hope?" online: LunarLand.com <http://www.lunarland.org/dr-dennins-hope>.
[80] *Moon Agreement*, art 11(4).
[81] Without going into further specifics, States Parties agreed that the international regime will include:

> a) The orderly and safe development of the natural resources of the Moon;
> b) The rational management of those resources;
> c) The expansion of opportunities in the use of those resources;
> d) An equitable sharing by all States Parties in the benefits derived from those resources, whereby the interest and needs of the developing countries, as well as the efforts of those countries which have contributed either directly or indirectly to the exploration of the Moon, shall be given special consideration:

Moon Agreement, art 11(7).

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feasible.[82] In order to facilitate the development of the regime, States Parties also agree to inform one another of the resources that they may find on the Moon.[83]

The restriction on claims of sovereignty or ownership in the *Moon Agreement* precludes the exploitation of natural resources on the Moon, however it allows exploitation to the extent that it is required to support the mission of a States Party. Arguably, this leaves the door open for States to exploit as much as they want and use it to expand their space capabilities immensely:

> In carrying out scientific investigations and in furtherance of the provisions of this Agreement, the States Parties shall have the right to collect and remove from the Moon samples of its mineral and other substances... States Parties may in the course of scientific investigations also use mineral and other substances of the Moon in quantities appropriate for the support of their missions.[84]

The *Moon Agreement* has not been ratified by any of the major space faring nations, with the exception of Australia, which is an "emerging major space faring nation".[85] It is therefore unclear whether an agreement will be made in the future with respect to the exploitation of the natural resources which might be found in outer space. It is unknown what resources are there, how much they will be worth, and how much it will cost to extract them. Therefore, States are cautious to give up the possibility of ownership or the ability to exploit resources which could be potentially lucrative for governments and commercial entities alike.

Rescue and Return Agreement

The humanitarian principle of rendering assistance to those in need was established by the law of the Sea and is embodied in the *Chicago Convention* in relation

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[82] *Moon Agreement*, art 11(5).
[83] *Moon Agreement*, art 11(6).
[84] *Moon Agreement* art 6(2) [emphasis added].
[85] Graham Gibbs, "An Analysis of the Space Policies of the Major Space Faring Nations and Selected Emerging Space Faring Nations" (2012) XXXVII Annals Air & Sp L 279 at 318.

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to air law.[86] Both at sea and in the air, "search and rescue are now imbedded into the culture… It is absolutely expected that vessels will assist in the search of other vessels, monitor distress signals and generally go to the air/rescue of another vessel if required to do so".[87] This notion is codified in space law in the form of the *Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space*, or the "*Rescue Agreement*" and the *Outer Space Treaty*. The object and purpose of the *Rescue Agreement* is to promote international cooperation in outer space activities and has a humanitarian objective. The *Outer Space Treaty* requires States Parties to "regard astronauts as envoys of mankind in outer space" and to render "all possible assistance", including returning astronauts "to the State of registry of their space vehicle" if they should be involved in an accident, become distressed, or require emergency assistance on another States' territory or in an area where a State is in a position to render assistance over the high seas.[88]

The provisions relating to rescue and return embody four (4) principles:

(1) The duty of notification of a State who is informed of or discovers "personnel of a spacecraft [that] have suffered accident or are experiencing conditions of distress or have made an emergency or unintended landing".
(2) The duty to return space objects or their component parts found outside the State of registry.[89]
(3) The duty to "render all possible assistance" to astronauts "in the event of accident, distress, or emergency landing" on its territory, and on safe landing to return them to the State of registry.[90]

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[86] *Chicago Convention,* art 25.
[87] Darcy Beamer-Downie, "Considering the Unthinkable – A Review and Discussion of Current International Law and Suggestions Regarding How We Deal with a Catastrophic Incident in Space" (2013) 92 Acta Astronautica 255 at 260.
[88] *Outer Space Treaty*, art V.
[89] *Outer Space Treaty*, art VIII.
[90] *Outer Space Treaty*, art V; *Rescue Agreement*, arts 2 & 4.

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(4) The duty to inform other States and/or the Secretary General if a State finds anything in outer space that "could constitute a danger to the life or health of astronauts".[91]

Each State Party that receives information or discovers astronauts in distress has two separate duties of immediate notification. The State must notify the launching authority or, if unable to identify and immediately communicate with the launching authority, immediately make a public announcement by all appropriate means of communication at its disposal.[92] Furthermore, the State shall also notify the UN Secretary General who should disseminate the information without delay by all appropriate means of communication at its disposal.[93]

Article 2 of the *Rescue Agreement* sets out that:

> If, owing to accident, distress, emergency or unintended landing, the personnel of a spacecraft land in territory under the jurisdiction of a Contracting Party, it shall immediately take all possible steps to rescue them and render them all necessary assistance...[94]

This language goes one step further than the comparable provision in the *Chicago Convention*, which requires a State "to provide such measures of assistance to aircraft in distress in its territory as it may find practicable".[95] This is presumably due to the contemplation of astronauts being "envoys of mankind",[96] as opposed to space tourists who engage in such activities for their own benefit, which is similar to the situation of aircraft passengers. If they are in a position to do so, States Parties are also under an

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[91] *Outer Space Treaty*, art V.
[92] *Rescue Agreement*, art 1(a).
[93] *Rescue Agreement*, art 1(b).
[94] *Rescue Agreement*, art 2 [emphasis added].
[95] *Chicago Convention,* art 25 [emphasis added].
[96] *Outer Space Treaty*, art V.

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obligation to render assistance to personnel who "have alighted on the high seas or in any other place not under the jurisdiction of any State".[97]

If a State Party receives information or discovers that a space object or its component parts has returned to that States territorial lands or waters, it shall take all practicable steps to recover, hold, and/or dispose of the space object or its component parts, as applicable.[98] If a possible danger of harm exists, the State Party shall notify the launching authority who must immediately take effective steps to eliminate that danger.[99] The launching authority refers to the State or international intergovernmental organization responsible for launching the space object.[100]

Upon the completion of the *Rescue Agreement,* the Chairman of UNCOPUOS said that it "would represent not only an important step forward in the elaboration of the law of outer space, but also evidence of the cooperation and unity of all nations in the great venture of man in the exploration of outer space".[101] However, the cooperation and unity of nations is not necessarily enough to create a fulsome treaty that is "one which will stand the test of time and experience".[102] As time and experience is making clear, there are many further areas in need of consideration due to the changing nature and players of the space industry.

One of the key issues is determining to whom the obligation is owed. The wording of the *Rescue Agreement* applies to "personnel of a spacecraft". Spaceflight passengers, tourists, and residents were never within the contemplation of UNCOPUOS when the space laws, particularly the *Rescue Agreement*, were drafted. The *Rescue Agreement* only contemplates "personnel of a spacecraft", which at that time were

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[97] *Rescue Agreement*, art 3.
[98] *Rescue Agreement*, art 5.
[99] *Rescue Agreement*, art 5
[100] *Rescue Agreement*, art 6.
[101] The Chairman of UNCOPUOS at the time was the Austrian delegate, Mr. Waldheim: *UNISPACE III* at 71.
[102] *UNISPACE III,* at 71.

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exclusively governmentally trained astronauts or cosmonauts. The question "What is an astronaut?" is almost absurd, as the very word "has the 'elephantine quality of being easy to recognize' – you cannot define it, but you know when you see it. The term conjures a picture of a space suited figured drifting in space with the Earth in the background or bouncing about on the Moon".[103] At the time of drafting the *Rescue Agreement*, this was the only contemplated form of astronaut: "a highly trained state-employed professional".[104]

The term is evolving with the advent of space travel, with some commercial entities declaring that persons will become astronauts when reaching a certain vertical point.[105] However, an analogy can be made between spaceflight and other forms of transportation. A passenger on an airplane does not automatically become a pilot by virtue of reaching the pilots domain at 37,000 feet, and a guest on a cruise ship does not become a sailor after one night at sea.[106] Therefore, the term "astronaut" is especially unclear and uncertain in its application to astronauts vis-à-vis space tourists. Uncertainty surrounding the definition of the term could lead to uncertainty in the application of the duties under the *Outer Space Treaty* and the *Rescue Agreement*.[107] Therefore, this is a serious lacuna that needs to be addressed as new forms of commercial space transportation emerge.

However, while the application of the *Rescue Agreement* and *Outer Space Treaty* are unclear when it comes to space tourists, "the travelling public has a reasonable expectation of rescue and return from a space excursion".[108] Therefore, it is likely that the humanitarian principles embodied in space law will be applied in the event that a space

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[103] F. Lyall, "Who is an Astronaut? The Inadequacy of Current International Law" (2010) 66 Acta Astronautica 1613 at 1613 [footnotes omitted].
[104] *Ibid*.
[105] Virgin Galactic, "Your Flight to Space: This is How You Will Become an Astronaut", online: Virgin Galactic <http://www.virgingalactic.com/human-spaceflight/your-flight-to-space/>.
[106] *Supra* note 103 at 1613.
[107] *Ibid,* at 1616.
[108] *Supra* note 87 at 258.

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tourist is in need of rescue or return, despite the wording of the treaties. The "likelihood", however, should not be put to the test and States should come to consensus now as to how these issues will be handled going forward.

Liability Convention

Right now the cost of traveling into space is upwards of US$250,000.00[109] Therefore, those who can afford to participate are, presumably, wealthy or high net worth individuals. Considering the equitable and customary international law principles that one who causes damage to another must put them back to the state they would have been in but for the damage caused,[110] there can be no doubt that any accident or injury will incur damage worthy of compensation in one way or another. Consider an individual with four dependents with a yearly salary of US$1 Million. The individual has 10 years left in their working life when they are tragically killed in a space accident. While there are particular calculations and formula that would apply to determine the precise figure of loss, the dependents' claims would be substantial. Accordingly, in addition to creating the most technologically advanced spaceships, legal safeguards need to be put in place in order to establish a limitation on liability in order to prevent a claim for compensation with the potential to cripple spaceflight operators and affect the growth of the industry.

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[109] Virgin Galactic, "Ready to Become an Astronaut?" online: Virgin Galactic <http://www.virgingalactic.com/human-spaceflight/fly-with-us/>.

[110] The *Chorzow Factory Case*, 1928, enunciates the general principle of law that whenever a State causes injury, they must restore the damaged party to the greatest extent practicable. Restoration must, as far as possible, wipe out all the consequences of the illegal acts and re-establish the situation that would have existed if the act had not been committed: *Case Concerning the Factory at Chorzów (Claim for Indemnity)* (1927), PCIJ (Ser A) No 9; The *Trial Smelter Case* enunciates the general principle of law that "no State has the right to use or permit the use of its territory in such a manner as to cause injury". In the *Trial Smelter Case,* smoke crossed the US/Canada border and contaminated the Canadian airspace: *Trail Smelter Case (United States, Canada)* (1938-41), III RIAA 1905-1982; The *Corfu Channel Case* enunciates the principle that a State cannot use its own territory to cause damage, even within its own territory. States have a duty to warn upon becoming aware of any potential damage. In the *Corfu Channel Case*, the State of Albania put mines in their territorial waters without warning others so that British warships would go through and be destroyed: *The Corfu Channel Case (Merits)*, Judgment of 9 April 1949 [1949] ICJ Rep 1.

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The *Convention on International Liability for Damage Caused by Space Objects* (the "*Liability Convention*")[111] was developed by UNCOPUOS, and came into force in 1972. The *Liability Convention* provides that "[a] launching State shall be absolutely liable to pay compensation for damage caused by its space objects on the surface of the Earth or to aircraft in flight".[112] Absolute liability does not apply in the case that the damage is caused in a non-terrestrial location or to another space object. In that case, strict liability attaches and a State "shall be liable only if the damage is due to its fault".[113] The *Liability Convention "*also provides for procedures for the settlement of claims for damages".[114]

The *Liability Convention* establishes a regime whereby a launching State is absolutely liable[115] to make reparation for damage caused to the earth.[116] Fault based liability applies if the damage is caused elsewhere than on the surface of the earth.[117] If one States space object causes damage to another States space object, which in turn causes damage to a third State, the parties "shall be jointly and severally liable",[118] based on an apportionment of fault. Liability is absolute if the damage is caused "on the surface of the Earth or to aircraft in-flight".[119] Similarly, if two States jointly participate in the launch of the space object, those States are jointly and severally liable, but retain the right to present a claim for indemnification against one another.[120] A launching State shall be exonerated from absolute liability if it can be established that the damage was caused by the claimant's gross negligence or intent to cause damage; however if the relevant space

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[111] *Liability Convention*
[112] *Liability Convention*, art II.
[113] *Liability Convention,* art III.
[114] UNOOSA, "Convention on International Liability for Damage Caused by Space Objects", online: UNOOSA <http://www.unoosa.org/oosa/SpaceLaw/liability.html>.
[115] *Liability Convention,* art II.
[116] *Liability Convention,* art XII.
[117] *Liability Convention,* art III.
[118] *Liability Convention*, art V.
[119] *Liability Convention,* art IV
[120] *Liability Convention,* art V.

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activity was not in conformity with international law, including the UN Charter and the *Outer Space Treaty*, no exoneration whatsoever will be granted.[121]

A State that suffers damage,[122] including damage suffered by its natural or juridical persons, or may present a claim for compensation for damage[123] to a launching State through diplomatic channels,[124] within one year following the date of discoverability of the occurrence, or the identification of the launching State.[125] The date of discoverability will not exceed one year following the date the claimant knew or ought to have known of the damage.[126] The limitation period does not preclude a State from amending their claim in the event that the full extent of the damage is not known upfront.[127] It is of note that only a State may present a claim for compensation. Neither a natural nor juridical person has standing under the *Liability Convention* to bring a claim, instead the request must be made to their State in order to bring the claim. Further, since the *Liability Convention* only applies to States, in the event that a private corporation of one State caused damage to a private corporation of another State, under this regime the private corporations would each have to deal with their respective States in order to bring a claim for compensation.

The *Liability Convention* is no longer suitable as it fails to take into account the evolution of the commercial spaceflight industry and its participants. The provisions of the *Liability Convention* do not apply to damage caused to nationals or foreign nationals of the launching State participating in the operation of that launching States' space object.[128] This is a shortcoming of the *Liability Convention,* as it may result in the

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[121] *Liability Convention*, art VI.
[122] Damage is defined as "loss of life, personal injury or other impairment of health; or loss of or damage to property of States or of persons, natural or juridical, or property of international intergovernmental organizations": *Liability Convention*, art 1.
[123] *Liability Convention*, art VIII.
[124] *Liability Convention*, art IX.
[125] *Liability Convention*, art X.
[126] *Liability Convention*, art X.
[127] *Liability Convention*, art X.
[128] *Liability Convention*, art VII.

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application of fragmented law in the event of an accident or incident involving spaceflight participants from different States. The *Liability Convention* also specifies that "a State, or natural or juridical persons it might represent," is not prevented from pursuing remedies that might otherwise be available through a States' court or administrative tribunal processes.[129] A State is, however, precluded from bringing a claim in respect of the same damage in more than one forum.[130] This could solve the issue noted above with respect to claims by private corporations against a private corporation, but there is no uniformity.

If States cannot resolve their dispute through diplomatic or national channels, the *Liability Convention* provides for a three-member [131] Claims Commission to be established "at the request of either party".[132] The Commission will determine their own procedure [133] and will "decide the merits of the claim", including the quantum recoverable. [134] The *Liability Convention* also suggests that a State Party "examine the possibility of rendering appropriate and rapid assistance", at the request of a claimant State, if the damage "presents a large-scale danger to human life or seriously interferes with the living conditions of the population or the functioning of vital centres".[135]

Just like there is difficulty in foreseeing whether the provisions of the *Rescue Agreement* that deal with the "personnel", it is also difficult to ascertain whether the provisions of the *Liability Convention* would apply to suborbital vehicles. Experts have agreed that there is uncertainty in the application of the *Liability Convention* to some forms of space travel, in particular suborbital forms of transportation.[136]

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[129] *Liability Convention*, art XI.
[130] *Liability Convention*, art XI.
[131] *Liability Convention*, art XV.
[132] *Liability Convention*, art XIV.
[133] *Liability Convention*, art XVI.
[134] *Liability Convention*, art XVIII.
[135] *Liability Convention*, art XXI.
[136] Stephan Hobe, "Project 2001 Plus: Global and European Challenges for Air and Space Law at the Edge of the 21st Century" (Paper delivered at the 56th International Astronautical Congress Congress of The International Astronautical Federation, The International Academy of Astronautics, and The

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Chapter Three: National Space Law

Space law has been put into place by individual States with on a national or domestic level, with varying levels of usefulness to support sub-orbital flight as it is envisaged today, and to continue to support commercial space transportation as it evolves into different forms of space travel. Since 1979, the development of international space law has stopped, with the last "hard law" obligations created by the *Moon Agreement*. A number of States have created their own domestic regulations as their national space activities evolve in ways that are not adequately protected by the current state of international regulation. Some States have implemented national or domestic space laws, encompassing their obligations under the international treaties, and adding additional layers of regulation depending on the space activities engaged in by its nationals. It is suggested that some of the similarities in national legislation may prepare the international community for unification on new international space law. National space laws also help to show the lacunae that States have identified and tried to clarify.

As noted above, under international space law, corporations and individuals are not legally competent to bring a claim.[137] The reality is that no matter how rich or powerful the corporation or private entity engaging in Space activities may be, the State is responsible for their actions under international space law.[138] While the argument can be made that the State will not ultimately be responsible to pay for any damage caused, it does not relieve the State from the responsibility for space objects launched or procured from its territory or by its nationals. If a space object causes damage to another State, it

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International Institute of Space Law, Fukuoka, Japan 17-20 October 2005), IAC-05-E.6.4.04, at 332 online: Aerospace Research Centre <http://arc.aiaa.org/doi/abs/10.2514/6.IAC-05-E6.4.04>.

[137] José Monserrat Filho, "Corporations and Space Law" in International Institute of Space Law, *Proceedings of the 48th Colloquium on the Law of Outer Space* (The Hague: Eleven International Publishing, 2005) 253 at 259.

[138] *Outer Space Treaty*, art VII, further elaborated upon by the *Liability Convention* where under that Convention, a State is absolutely liable to pay compensation for damage caused by its Space object on the surface of the Earth or to aircraft in flight.

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will be the State who will be named in a claim for compensation and the State will be responsible to ensure that it has appropriate procedures in place to claim from the private entity. Therefore, space activities must be closely guarded by the State, and it must authorize and continually supervise the space activities of its nationals. States engaged in space activities should have some sort of licensing process to review and authorize prospective launches, tests, and/or space activities.

With States moving towards national legislation, UNCOPUOS has reached consensus about some elements that should be considered for the development of national space laws. The *Recommendations on National Legislation Relevant to the Peaceful Exploration and Use of Outer Space,*[139] were adopted by the General Assembly on 11 December 2013. The General Assembly "*observ[ed]* that, in view of the increasing participation of non-governmental entities in space activities, appropriate action at the national level is needed, in particular with respect to the authorization and supervision of non-governmental space activities".[140] Further, the General Assembly "*not[ed]* the need for consistency and predictability with regard to the authorization and supervision of space activities". [141] The recommendation is that that States consider including the following in their national regulatory frameworks, as appropriate:

1. the scope of space activities targeted;
2. the conditions for jurisdiction and control over space activities;
3. a competent authority to authorize space activities and launches;
4. conditions for authorization that minimize the risk, environmental impact, and harmful interference of space activities;
5. procedures for continuous supervision and enforcement mechanisms;
6. procedures for registration of space activities and the establishment of a national register;
7. insurance and indemnification procedures in the event that the States' liability is enraged;

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[139] *Recommendations on National Legislation Relevant to the Peaceful Exploration and Use of Outer Space*, GA Res 68/74, UNCOPUOS, 68th Sess, UN Doc A/Res/ 68/74 (2013).
[140] *Ibid.*
[141] *Ibid.*

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8. continuous supervision, authorization, and registration requirements during in orbit transfers of ownership of space objects.[142]

These mechanisms can form a foundation for national space law that compliment the international space law regime in a real and meaningful way.

United States of America

The United States has a comprehensive national legal regime in space, which encompasses many aspects, including commercial space transportation and other forms of commercial uses of outer space. Early in the development of commercial space services, the United States introduced the *Commercial Space Launch Act of 1984* ("*CSLA* 1984"). Since that time, the national legislation put in place by the US has evolved significantly as the commercial uses of outer space change, and is now sufficiently comprehensive that it provides guidance for other States' implementation of national laws. The United States official space policy, disseminated by the President in 2013, sets out that the Secretary of Transportation and other appropriate government agency heads shall "[a]dvocate internationally for the adoption of United States Government safety regulations, standards, and licensing measures to enhance global interoperability and safety of international commercial space transportation activities".[143]

A concise summary of the applicable US domestic legislation, as précised by the UNCOPUOS Working Group on National Legislation Relevant to the Peaceful Exploration and Use of Outer Space, is set out below:

> Any citizen of or entity organized under the laws of the United States, as well as other entities, as defined by space-related regulations, which are intended to conduct in the United States a launch of a launch vehicle, operation of a launch or re-entry site, re-entry of a re-entry vehicle, should obtain a license from the Secretary of Transportation, which may be of various types and may be modified, suspended or revoked (51 U.S.C. 50904-50906). No person that is subject to the jurisdiction or control of

[142] *Ibid.*
[143] US, President of the United States, *National Space Transportation Policy* (Washington, DC: Office of the President of the United States, 21 November 2013) at 5.

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> the United States may, directly or through any subsidiary or affiliate, operate any private remote sensing space system without a license, which may be modified, suspended or revoked by the Secretary of Commerce (51 U.S.C. 60121- 60123). No person shall use or operate an apparatus for the transmission of energy or communications to or from the United States, or by a mobile station under the jurisdiction of the United States, except under, and in accordance with, an appropriate authorization granted by the Federal Communications Commission. A launch authorization and station license must be applied for and granted before a space station may be launched and operated. The FCC may terminate station authorizations in accordance with 47 C.F.R. 25.160-162.[144]

The United States Congress "declares that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all humankind".[145] Congress further "declares that the general welfare of the United States requires that the Administration seek and encourage, to the maximum extent possible, the fullest commercial use of space".[146] The associated policies reflect the recognition by the United States government that the development of commercial space services contributes to the economic well-being of the United States. As a result, the United States' policy is to promote these activities through minimal regulation.[147] While aiming for minimal regulation, the United States also recognizes the inherently risky nature of space activities and notes that "the future of the commercial human space flight industry will depend on its ability to continually improve its safety performance".[148] Further, the United States is

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[144] Working Group on National Legislation Relevant to the Peaceful Exploration and Use of Outer Space, *Schematic Overview of National Regulatory Frameworks for Space Activities*, UNCOPUOS, 2014, online: UNOOSA <http://www.unoosa.org/pdf/spacelaw/schem/schematic-overview_2014-03.pdf>.

[145] *National Aeronautics and Space Act*, 51 USC §20102(a).

[146] *National Aeronautics and Space Act*, 51 USC §20102(c).

[147] 49 USC § 70101(a)(7) reads:

> the United States should encourage private sector launches, reentries, and associated services and, only to the extent necessary, regulate those launches, reentries, and services to ensure compliance with international obligations of the United States and to protect the public health and safety, safety of property, and national security and foreign policy interests of the United States [emphasis added].

[148] 49 USC § 70101(a)(12).

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of the position that "the public interest is served by creating a clear, legal, regulatory, and safety regime for commercial human space flight",[149] and that "the regulatory standards governing human space flight must evolve as the industry matures so that regulations never stifle technology development nor expose crew or space flight participants to avoidable risks".[150]

Commercial space transportation services play a large role in the United States' use and exploration of outer space. Specifically, if the United States is conducting space transportation services (such as, for the delivery of crew or cargo to the ISS), the United States "shall acquire space transportation services from United States commercial providers".[151] The historic Space Shuttle program has been privatized in accordance with the Administrations "mandate to promote the fullest possible commercial use of space".[152]

The United States requires a person to have a license or permit in order "to launch a launch vehicle or to operate a launch site or reentry site, or to reenter a reentry vehicle into the United States".[153] These requirements equally apply to a citizen of the United States who engages in those activities outside of the United States, or who holds a controlling interest in a space activity that takes place outside of the United States.[154] A license may be issued by the Secretary of Transportation (the "Secretary"), with or without conditions,[155] if, having regard to the "public health and safety, safety of property and national security and foreign policy interests of the United States," the Secretary decides that the applicant complies, an will continue to comply, with certain prescribed regulations.[156] The Secretary may waive a requirement "if the Secretary decides that the

[149] 49 USC. § 70101(a)(14).
[150] 49 USC § 70101(a)(15).
[151] 51 USC §50131.
[152] 51 USC §50133.
[153] 51 USC §50904(a).
[154] 51 USC §50904(a).
[155] 51 USC §50905(b).
[156] 51 USC §50905(a).

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waiver is in the public interest and will not jeopardize the public health and safety, safety of property, and national security and foreign policy interests of the United States".[157] However the Secretary may not waive the requirement to hold a license or permit if it would permit the launch or re-entry of a space vehicle in cases where a human being will be on board.[158]

The Federal Aviation Administration ("FAA") has established the Office of Commercial Space Transportation ("AST"), whose mission "is to ensure protection of public, property and the national security and foreign policy interests of the United States during commercial launch or reentry activities, and to encourage, facilitate, and promote U.S. commercial space transportation".[159] Prospective operators must meet with the AST early on in the development phases in order to discuss potential issues related to the proposed operations.[160] Licence applicants must obtain policy and safety approvals from the AST, which includes an examination of national security and foreign policy issues, foreign ownership, and participating foreign entities.[161] The level of commercial space transportation activity has increased significantly in the United States in recent years and the Associate Administrator for Commercial Space Transportation at the FAA has stated that "the prospects for continued growth are solid".[162] In 2012, there were three licensed launches, in 2013, there were eighteen, and as of May 2015, that number has grown to 238 licensed launches.[163] These are all signs of exponential industry growth.

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[157] 51 USC §50905(b).
[158] 51 USC §50905(b)(3).
[159] FAA "Office of Commercial Space Transportation" (18 May 2015) online: FAA/AST <http://www.faa.gov/about/office_org/headquarters_offices/ast/>.
[160] 14 CFR § 413.5
[161] P.A. Vorwig, "Regulation of Private Launch Services in the United States" in Ram Jakhu, ed, *National Regulation of Space Activities* (Springer 2010) p 410; 14 CFR § 415.25 (ELV); 14 CFR § 431.25.
[162] US, *Necessary Updates to the Commercial Space Launch Act: Hearing before the Subcommittee on Space, Committee on Science, Space and Technology*, 113th Cong (4 February 2014) (Statement of Dr. George C. Nield).
[163] *Supra* note 159.

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UNCOPUOS summarized that "for all types of authorizations and permits, the FAA conducts a safety review to determine whether the applicant is capable of conducting the proposed activity without jeopardizing public health and safety, and safety of property".[164] Conditions are imposed on each license or permit, whereby each licensee or permit holder must specifically inform crew or spaceflight participants that the launch vehicle is not certified as "safe" by the United States Government.[165] Those individuals may also be required to undergo medical examinations and satisfy medical standards.[166] Spaceflight participants must provide "written informed consent to participate in the launch and reentry".[167] There are questions as to how "informed" a spaceflight participant may be. Further, because spaceflight involves the risk of death, the question arises as to whether someone can "consent" to their own death.

Additionally, when a launch or re-entry license is issued or transferred, the licensee must "obtain liability insurance or demonstrate financial responsibility" for no less than the "maximum probable loss" from claims by a third party for damage incurred as a result of the licensed activity, and claims by the US Government for damage to Government property as a result of the licensed activity.[168] However, the maximum amount of insurance or demonstration of financial responsibility required shall not exceed $500,000,000.00 for damage to third parties and $100,000,000.00 for damage to Government property.[169] Launch and re-entry licenses will contain provisions requiring cross-waivers of liability for contractors, subcontractors, and customers.[170] Additionally, and subject to Congressional appropriation, the US Government will provide payment for any successful claims exceeding the insured amounts up to a statutory maximum of $1.5 billion (reflected for inflation).[171] However, the US Government will not indemnify the

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[164] *Supra* note 144 citing 51 USC 50904, 50905(a), 50906; 14 CFR parts 413, 415, 417, 420, and 437.
[165] 51 USC §§50905(b)(4)&(5).
[166] 51 USC §§50905(b)(6).
[167] 51 USC §50905(b)(5)(C).
[168] 51 USC §50914(a)(1).
[169] 51 USC §50914(a)(2).
[170] 51 USC §50914(b).
[171] 51 USC §50915(a).

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licensee for damage to space flight participants or if the damage results from wilful misconduct.[172]

Europe

The European Space Agency ("ESA") has defined space tourism as "suborbital flights [performed] by privately operated vehicles and the associated technology development driven by the space tourism market".[173] ESA's Space Activities have many different dimensions,[174] and in the process of considering the many aspects of space tourism that may have an impact on ESA, Europe is considering topics such as "[t]echnology and operations",[175] "[c]ommercialisation and partnership development",[176] "[l]egal aspects and regulatory framework",[177] and "[c]ommunication aspects and visibility of space activities".[178] ESA considers that a fully competitive marketplace must not be interfered with, but takes "a position of cautious interest and informed support".[179] Their position is shaped by guidelines:

- Monitoring relevant technology activities and assessing if "spin-offs" or "spin-ins" could be envisaged for European space activities;
- Further reflecting on developing partnerships with commercial entities, and developing legal schemes to guide the liability exposure in those partnerships;
- Provisioning ESA's capabilities, expertise, and/or facilities in astronaut training and space medicine for space tourist training;
- Contributing to the development of the regulatory framework for space tourism in Europe by involving both the civil aviation regulatory authorities and the European Commission

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[172] 51 USC §50915(a).
[173] Andrés Gálvez & Géraldine Naja-Corbin "Space Tourism: ESA's view on Private Suborbital Spaceflights", *ESA Bulletin* 135 (August 2008) 18, online: esa.int <http://www.esa.int/esapub/bulletin/bulletin135/bul135c_galvez.pdf> at 19.
[174] *Ibid,* at 21.
[175] *Ibid,* at 21.
[176] *Ibid,* at 21.
[177] *Ibid,* at 22.
[178] *Ibid,* at 23.
[179] *Ibid,* at 24.

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- Facilitating the free flow of ideas by establishing voluntary information exchange.[180]

The civil aviation regulatory authority that is involved in the development of the regulatory framework for ESA is the European Aviation Safety Agency ("EASA"). EASA is the agency responsible for the regulation of aviation safety, including airworthiness, air operations and flight crew licensing in the European Union ("EU"). EASA interprets ICAO's definition of "aircraft" as including sub-orbital aeroplanes which generate lift during the atmospheric portion of the flight. Accordingly, EASA considers these sub-orbital aeroplanes to be "aircraft" [181] and, accordingly, the airworthiness, crews, and operations fall under EASA's remit.[182] Due to EASA's specialized expertise, the EU legislator prescribes that legally binding rules for airworthiness "can only be adopted by the European Commission after having received an opinion from the EASA for that purpose".[183] EASA, therefore, is the regulatory body for sub-orbital space transportation in Europe. Their approach is pro-active, but not to the point of over-regulating. EASA has chosen "to complement existing rules to capture the specific features of such Sub-Orbital Aeroplanes, rather than developing new specifications from scratch".[184] This 'small steps' approach, "allows to accommodate new technologies and operational ranges, while minimizing the effort, resources and associated programmatic risk".[185]

Generally speaking, EASA will certify that an aircraft is airworthy by issuing a Type Certificate following a technical investigation.[186] The technical investigation may include "special conditions if necessary to address 1) Unusual features, or 2) Unusual

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[180] *Ibid,* at 24.
[181] Jean-Bruno Marciacq et al, "Accommodating Sub-Orbital Flights into the EASA Regulatory System" in Joseph Pelton & Ram Jakhu, eds, *Space Safety Regulations and Standards* (Burlington, MA: Elsevier Ltd, 2010) 187 at 191.
[182] *Ibid* at p 191.
[183] *Ibid* at p 191
[184] *Ibid* at p 188.
[185] *Ibid* at p 188.
[186] *Ibid* at p 193.

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operations, or 3) Features for which experience in service on similar design has shown that an unsafe condition may develop".[187] EASA's primary objective is to "ensure as much as possible that the public is not unduly affected by [an operator's] operations or activities".[188] In achieving this objective, EASA must ensure that hazards and associated risks are identified and analyzed in order to determine how best to mitigate the risk.[189] There is, however, a careful balance that must be struck between risk mitigation and over-regulation. EASA must be careful to implement measures that will safeguard the public interest, while refraining from over-regulating and "creating undue restrictions that are not justified by [the safety] objective".[190]

Each aircraft type has its own airworthiness code, but there are none in existence at this time for sub-orbital aeroplanes. EASA has considered that it could use an existing airworthiness code as a basis, however compliance with the essential requirements of such a code may be difficult for sub-orbital aeroplanes, particularly during the rocket/ballistic phase.[191] Due to this inherent difficulty, EASA has considered the possibility of issuing a Restricted Type Certificate ("RTC"). An RTC may be issued "when the type certificate is inappropriate and the aircraft is designed for a special purpose, for which the Agency agrees on the fact that it justifies deviations from the essential requirements".[192] Ironically, due to the more flexible character of a "restricted" type certificate, EASA considers the issuance of "RTCs seems like the most realistic avenue for sub-orbital aeroplanes".[193]

EASA has also considered the possibility of issuing a Restricted Certificate of Airworthiness, and a Permit to Fly. However, the Restricted Certificate of Airworthiness would be issued by Member States but approved by EASA, which could cause confusion

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[187] *Ibid* at p 193-4.
[188] *Ibid* at p 194.
[189] *Ibid*.
[190] *Ibid*.
[191] *Ibid*.
[192] *Ibid*.
[193] *Ibid*.

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and fragmentation and thus it "is not favoured by the Agency for continuing airworthiness reasons".[194] Permits to Fly may not be appropriate as they are not permitted for commercial operations, but may be the best option for flight testing.[195]

EASA is competent to certify types or sub-orbital vehicles as aircraft, their regulatory authority ceases where outer space begins.[196] As discussed above, all States are responsible for authorization and continuous supervision over their, or their nationals, respective space activities. This responsibility has not been delegated to the EU and thus all Member States maintain the responsibilities codified in the international space treaties.[197] Further clarity about the role of intergovernmental agencies is required in order to account for the unique structure of the EU's engagement with space activities.

Australia

In Australia, the Minister for Industry and Innovation (the "Minister") is responsible for regulation and authorization of space activities under the *Space Activities Act 1998* (Cth).[198] Authorization can be given in the form of a space license, a launch permit, and/or an overseas launch certificate.[199] The Minister will give approval based on consideration of "such matters as launch safety, incident investigations, etc.".[200] Furthermore, requirements for safety, insurance and financial responsibility are imposed on applicants engaging in space activities.[201] The Minister also maintains a national register of space objects.[202]

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[194] *Ibid*.
[195] *Ibid*.
[196] *Ibid*, at p 201.
[197] *Ibid*.
[198] *Supra* note 144 at p 3.
[199] *Ibid.*
[200] *Ibid.*
[201] *Ibid.*
[202] *Ibid.*

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Australian space law applies to the launch (and attempted launch) of a space object into outer space, the return (and attempted return) of a space object from outer space, and the operation of a launch facility.[203] Australian space law also applies to activities carried out from Australian territory including external territories, and space activities carried out by Australian nationals.[204] "Australian national" is defined as (a) an Australian citizen, (b) a body incorporated by or under the law of the Commonwealth of Australia, or (c) the Commonwealth, or a state or territory.[205]

Notably, the *Space Activities Act 1998* (Cth) ("*Space Activities Act*")[206] could be interpreted to effectively codify the line of demarcation between air space and outer space. While there is no provision that specifically states that the line is drawn at 100km above mean sea level, the *Space Activities Act* includes the following definitions:[207]

> ***launch*** a space object means launch the object into an area beyond the distance of 100 km above mean sea level, or attempt to do so.
>
> ***launch vehicle*** means a vehicle that can carry a payload into or back from an area beyond the distance of 100 km above mean sea level.
>
> ***return*** a space object means return the space object from an area beyond the distance of 100 km above mean sea level to Earth, or attempt to do so.
>
> ***space object*** means a thing consisting of:
> (a) a launch vehicle; and
> (b) a payload (if any) that the launch vehicle is to carry into or back from an area beyond the distance of 100 km above mean sea level;
> or any part of such a thing, even if:
> (c) the part is to go only some of the way towards or back from an area beyond the distance of 100 km above mean sea level; or

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[203] *Ibid.*
[204] *Space Activities Act 1998* (Cth), s 3.
[205] *Space Activities Act 1998* (Cth), s 8.
[206] *Space Activities Act 1998* (Cth).
[207] *Space Activities Act 1998* (Cth), s 8.

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> (d) the part results from the separation of a payload or payloads from a launch vehicle after launch.

In terms of licensing, a space license is required to operate a launch facility in Australia and to launch a particular type of launch vehicle from such facility.[208] The Minister may grant a license after considering competency, environmental concerns, funding, public health and safety, national security, and any criteria prescribed by regulations relating to the specific launch facility or vehicle.[209]

A launch permit is required for all launches in Australia,[210] unless subject to an exemption certificate[211] or an agreement pre-existing the *Space Activities Act.*[212] Permits are also required for the return of space objects to Australia.[213] A launch permit can only be granted to the holder of a space license.[214] Furthermore, an overseas launch certificate is required for the launch of a particular space object or series of similar such launches from a specified launch facility outside Australia using a specified kind of launch vehicle.[215] The Minister keeps a national register of launches and space objects in order to fulfil its obligations under the *Registration Convention*.[216]

In the case of an accident involving a space object, all launch permits, etc. are automatically suspended until such time as the Minister revokes the suspension.[217] The Minister must appoint a qualified and experienced investigator for the accident.[218] The Investigator will "investigate the circumstances surrounding the relevant accident or

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[208] *Space Activities Act 1998* (Cth), s 15.
[209] *Space Activities Act 1998* (Cth), s 18.
[210] *Space Activities Act 1998* (Cth), s 11.
[211] *Space Activities Act 1998* (Cth), s 46.
[212] *Space Activities Act 1998* (Cth), s 109(1).
[213] *Space Activities Act 1998* (Cth), ss 13 & 14.
[214] *Space Activities Act 1998* (Cth), s 26(3)(a).
[215] *Space Activities Act 1998* (Cth), s 35.
[216] *Space Activities Act 1998* (Cth), s 76.
[217] *Space Activities Act 1998* (Cth), s 95.
[218] *Space Activities Act 1998* (Cth), s 88.

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incident", and any other terms of reference as determined by the Minister.[219] Upon completion of the investigation, the investigator will issue a written report.[220]

The issuance of a launch permit is conditional upon, *inter alia*, the Minister being satisfied that the person who is to carry out the launch and return has satisfied certain insurance and financial requirements.[221] In particular, the insurance requirements are satisfied only if the holder of the license or permit is insured "against any liability that the holder might incur… to pay compensation for any damage to third parties that the launch or return causes".[222] Further, the insurance requirements will not be satisfied unless "the Commonwealth is insured… against any liability that the Commonwealth might incur, under the *Liability Convention* or otherwise under international law, to pay compensation for such damage.[223] The total insurance for each launch or return must be for at least $750 million dollars, and is determined by calculating "the maximum probable loss that may be incurred in respect of damage to third parties caused by the launch or return".[224] Alternatively, if the holder can show direct financial responsibility for an amount not less than the amount of insurance that would otherwise be required.[225] A issuance of launch permit or license is also conditional upon a low probability that any launches and/or returns would cause "substantial harm to public health or public safety or caus[e] substantial damage to property".[226]

Canada

Unfortunately, Canada's space legislation is not as advanced as others noted above, but is worth mentioning for comparison purposes. In Canada, authorization and supervision of national space activities is performed under the auspices of the Department

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[219] *Space Activities Act 1998* (Cth), s 89.
[220] *Space Activities Act 1998* (Cth), s 93.
[221] *Space Activities Act 1998* (Cth), s 26(3)(d).
[222] *Space Activities Act 1998* (Cth), s 48(1)(c).
[223] *Space Activities Act 1998* (Cth), ss 48(1)(d) & 48(2).
[224] *Space Activities Act 1998* (Cth), s 48(3).
[225] *Space Activities Act 1998* (Cth), s 47.
[226] *Supra* note 144 at p 12, citing the *Space Activities Act 1998* (Cth), ss 18, 26 & 35.

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of Foreign Affairs and International Trade and Ministry of Transport through Canada's specialized agency that deals with all matters related to space: Canadian Space Agency ("CSA"). The CSA was established pursuant to the *Canadian Space Agency Act* ("*CSA Act*").[227] The objects of the CSA are "to promote the peaceful use and development of space, to advance the knowledge of space through science and to ensure that space science and technology provide social and economic benefits for Canadians."[228] The Minister "shall coordinate the space policies and programs of the Government of Canada"[229] and "is responsible for the operations of the CSA".[230] In furtherance of the objects of the CSA, the Minister may make loans and guarantee principal repayment on loans made "to any person in respect of the commercial exploitation of space science and technology".[231] The Minister may also prescribe any fees to be paid by a person to whom the Agency provides services, facilities, or license to use any intellectual property.[232]

The CSA "may exercise its powers and perform its duties and functions in relation to all matters concerning space over which Parliament has jurisdiction and that are not by or pursuant to law assigned to any other department, board or agency of the Government of Canada". [233] The CSA has the responsibility to maintain Canada's national registry of space objects and "gathers information on Canadian satellites placed in orbit and provides that information to the Department of Foreign Affairs and International Trade for the purpose of communicating such information the Secretary General of the UN via OOSA".[234]

The *CSA Act* does not provide the parameters for the authorization and supervision of outer space activities. The *Canadian Aviation Regulations* prescribe that

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[227] *Canadian Space Agency Act* SC 1990, c 13 s 3 [*CSA Act*].
[228] *CSA Act*, s 4.
[229] *CSA Act*, s 6.
[230] *CSA Act*, s 7.
[231] *CSA Act,* s 9.
[232] *CSA Act*, s 10.
[233] *CSA Act,* s 5(1).
[234] *Supra* note 144.

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the Minister of Transport authorizes rocket launches from Canadian territory.[235] Therefore, similar to the US and Europe's legislation, an understanding of Canadian space law requires an understanding of both air and space law.

Canada also has specialized statues to implement Canada's obligations arising from the ISS Agreement[236] governing remote sensing activities in Canada,[237] licensing and supervising Canadian Telecommunications Satellites, and authorizing radio frequencies used in satellite communications.[238] However, Canada does not have any statute that governs or refers to any commercial space activities.

It is important that States continue to develop their own national space laws as the industry grows. States who do not have their own national legislation in place, or who may identify that their legislation is lacking, may look to those States who have successfully implemented national space laws for guidance. The United States, in particular, views their national space law as a model for other States and encourages States to follow their model when implementing their own legislation. National space law is not a substitute for an international legal regime governing commercial space transportation, but it can be used as a model for unification on certain issues.

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[235] *Canadian Aviation Regulations* SOR/96-433 ss 602.43 & 602.44.
[236] *Civil International Space Station Agreement Implementation Act*, SC 1999, c 35.
[237] *Remote Sensing Systems Act and Regulations*, SC 2005, c 45.
[238] *Radiocommunication Act*, RSC 1985, c R-2.

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Chapter Four: Space Travel

Historically, outer space has been the province of astronauts and cosmonauts and has been exclusively funded by the governments of space faring nations. However, decreasing government budgets and increased private investment have caused a 'shift' in the space race. The space race is no longer an exclusive competition between States, but has evolved to include private individuals and corporations. Dozens around the world are taking on space projects,[239] and spaceports are also being designed to support the launch of these projects in, *inter alia*, the United States, Sweden, and Singapore.

Outer space is open for the commercial industry. Satellites, experimental research, and shuttles, are just some of the new ways that commercial entitles are benefiting from the exploration and use of outer space. The public is benefiting from the commercial use of space on a daily, if not hourly basis, and may not even realize or recognize that they are using space technology. There are an increasing number of satellites that are integral to communication and connectivity, including telecommunications satellites and Global Positioning Systems ("GPS"). Every time one uses their GPS, they are using space-based technology to gain directions to their next meeting or rendez-vous. Newer and more technologically advanced uses of space are constantly being researched, explored, and examined. New advances help the world to envision new possibilities for exploration and use of the undiscovered vastness that is outer space.

Emerging modes of commercial space transportation are helping the world to see the possibility of using space, not only for research and exploration by governments, but also for transportation. This idea is well founded in current technological advances, but it has many obstacles to implementation, including legal and political obstacles. Technicians, mechanics, pilots, crew, scientists, astronomers, safety experts, regulators, lawyers, entrepreneurs, mechanics, consumers, and many others have a role to play and

[239] *Supra* note 181.

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must work together, guided by the principle of cooperation and mutual assistance, to change the way the cosmos are used to enhance the world.

Commercial space transportation can be divided much the same way as the aviation industry is separated into "domestic" and "international" air travel. The former might relate to a "sub-orbital" or "domestic" flight, which will be launched from earth and return to the same point, without entering orbit. The flight would depart from, and land in, the same location, or country. The purpose of such a flight would be to experience space as a tourist and view the earth from a different perspective. This type of "domestic" space travel does not cross international boundaries, *per se*, and does not have the purpose of transporting passengers from one destination to another. The latter might relate to "point-to-point" or "international" space travel, which would transport passengers from one location to another. The destination could be another continent, a space hotel, or another location other than the point of origin.[240]

In addition to space tourism and space travel, there is the possibility that space passengers will be able to spend an extended period of time in outer space, much like the astronauts onboard the International Space Station ("ISS"). There are projects in the development stages that would create "Space Hotels" and establish planetary structures capable of sustaining human life. Spaceflight passengers could choose to return to earth or remain in outer space indefinitely and create the first (known) space colony.

A full understanding of the scope of emerging modes of aerospace transportation and proposed uses of outer space is required in order to fully appreciate the outer space activities that new space law would encompass. Space tourism, space transportation, space hotels, and space shuttles are all forms of space travel that have commercial markets and form part of the scope of space activities that must be kept in mind as new

[240] For the purposes of this definition, the "location other than the point of origin" need not be in a different country than the point of origin in order to meet the traditional definition of "international"; it suffices that the space vehicle take off from one location and land in another.

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regulations are contemplated. A failure to appreciate the evolving nature of this nascent industry would undoubtedly have a disastrous result.

As we evolve as a society and our needs change, our modes of transportation must change and improve to make our society function seamlessly. As a society, we have changed modes of transportation over time, from rail to roads to sea to air and now we are on the cusp of using outer space to make cross-continental trips in record time. A type of commercial space transportation, comparable to international air travel, is international space travel or "point-to-point" space transportation. This means that a spaceship will blast off from one country and use rocket systems and the earth's trajectory to reach another country in a very short amount of time. One of the goals of the commercial space transportation industry is to make point-to-point space travel a reality in order to connect the world quickly and seamlessly. The idea is that it will be possible to travel from New York to Sydney, a trip that now takes about twenty-three (23) hours in an airplane, in about three (3) hours in the near future. This form of point-to-point or intercontinental space transportation is attractive to those with a time-budget, such as: wealthy individuals, those traveling for business, and perhaps even intercontinental couriers.[241]

Dawn of Commercial Spaceflight

It is claimed that the "inauguration" of the commercial space age was September 9, 1982, when Space Services, Inc. of America ("SSIA") launched the first "privately funded rocket," Conestoga 1, into space.[242]

> SSIA sought to accomplish several key objectives with Conestoga 1: demonstrate the ability of the company to assemble the technology, finance, and team required to conduct space operations; demonstrate to investors and customers that the

[241] Ram Jakhu & Yaw Nyampong, "International Regulation of Emerging Modes of Space Transportation" in Joseph Pelton & Ram Jakhu, eds, *Space Safety Regulations and Standards* (Burlington, MA: Elsevier Ltd, 2010) 215 at 216.
[242] Space Services Inc. of America, "The Launch of Conestoga 1", online: Space Services Inc. of America <http://www.spaceservicesinc.com/#!conestoga-1/c1ku>.

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> Federal government would permit private space launches; and, qualify Matagorda Island as a spaceport.[243]

At that time, private space launches were not specifically noted in "statutes, policies, or regulations on the books anywhere".[244]

> SSIA early on received the support of the Reagan Administration … and engaged in a year-long effort to convince a variety of Federal agencies to approve the proposed launch. Because of the need to adhere to a strict schedule, SSIA initiated construction of the launch site and the launch vehicle well in advance of the receipt of Agency approvals, including receiving the final Federal approval – an export license from the US Department of State – only the weekend before the launch on September 9, 1982. Additional formal approvals included the Bureau of Alcohol, Tobacco, and Firearms, the Federal Aviation Administration, the Federal Communications Commission, NASA, and various elements of the Department of Defense.[245]

Commending SSIA on the successful launch of Conestoga 1, President Ronald Reagan stated, "in blazing a new trail through the skies, you have shown the potential of private enterprise to perform even the most sophisticated technical feats". SSIA has evolved since then and has had great success with government contracts. SSIA was awarded "the first NASA contract for the launch of payloads aboard private rockets, the first agreement to use a US national launch range, and the introduction of the first commercial land remote sensing satellite mission".[246]

SSIA's commercial market is not only government contracts. Charles Chafer, the Founder and CEO, is in favour of access to space for all and explains that the "goal of Space Services Inc. is to be the world's leader in public participation space missions".[247] He says that, "some people dream of success. We make it happen".[248] Because, let's face it, not everyone can afford a $250,000.00 trip to space. But in some cases going to space

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[243] *Ibid.*
[244] Richard W. Scott, Jr., "Policy/Legal Framework for Space Tourism Regulation" (2000) 28 J Space L 1 at 1.
[245] *Supra* note 242.
[246] *Ibid.*
[247] Space Services Inc. "Home Page" online: Space Services Inc. <http://www.spaceservicesinc.com>.
[248] Space Services Inc. "Services" online: Space Services Inc. <http://www.spaceservicesinc.com/#!services/ca4p>.

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can be accessible, if only in the afterlife. A meaningful send-off to a loved one who dreamt of going to space is an option offered by one of SSIA's affiliated companies and is more affordable than the typical spaceflight, but with a caveat: The dream of spaceflight will not be realized until the afterlife. This offering is a "post-cremation memorial spaceflight".[249] Celestis can be purchased for a loved one, or for oneself, and is targeted at those who "dream of spaceflight, marvel at the stars in the night sky, or contemplate the future through the works of science fiction".[250]

Sub-orbital Spaceflight

The International Civil Aviation Organization ("ICAO") defines sub-orbital flight as "a flight up to a very high altitude which does not involve sending the vehicle into orbit".[251] The purpose of sub-orbital spaceflight is purely to experience space for pleasure, and therefore it has at its very core the basic tenet of "space tourism". Suborbital space transportation provides a "tourist" experience, whereby one can experience the incredible thrill of taking off in a rocket, enter outer space, experience weightlessness and view the earth from a completely different perspective. The space vehicle then returns to the launch point or spaceport of origin. Several corporations have developed to provide a space tourism experience, with varying levels of preparedness for offering the service in the coming years.

Two forms of sub-orbital transportation are those being developed by XCOR Space Expeditions and Blue Origin. XCOR Space Expeditions offers sub-orbital spaceflight experiences to be called the "Founder Astronaut Program" for the first 100 spaceflight participants, and thereafter the "Future Astronaut Program".[252] The Founder Astronaut program is sold out.[253] XCOR boasts that their spaceflight participants will

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[249] Celestis, "About Celestis" online: Celestis <http://www.celestis.com/about.asp>.
[250] Celestis, "Advanced Planning" online: Celestis <http://www.celestis.com/advance_planning.asp>.
[251] Peter van Fenema, "Suborbital Flights and ICAO" (2005) 30 Air & Space Law 396 at 405.
[252] XCOR Space Expeditions, "The Flight: Programs" online: XCOR Space Expeditions <http://spaceexpeditions.xcor.com/the-flight/programs/>.
[253] *Ibid.*

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have eight (8) life changing experiences in the course of their 60-minute space flight.[254] Passengers will be "launched like a bullet" and will accelerate to "Mach 3: Spyplane Territory". This is followed by "perfect silence" and "instant weightlessness", as the rocket engines are switched-off at 103 km above the earth. This is where the spaceflight participants will become astronauts. The new astronauts will have "6 Minutes of enjoying Planet Earth as only 500 people have done before".[255] A "pull-out maneuver", followed by a forty-minute "glide back to earth" allows the newly minted astronauts to take in the view and prepare for the wing ceremony upon landing.[256] The XCOR Astronaut Program carries with it a $100,000.00 price tag, with 50% due upon, or shortly after, signing the contract to fly.[257]

Blue Origin's spaceflight experience markets the pioneering aspect of discovering the space frontier and "offers aspiring astronauts glimpse of the future and he opportunity to help humanity get there".[258] Their vehicles carry six (6) people at speeds up to Mach 3. "Following a thrilling launch, [the space tourists will] soar over 100 km above Earth—beyond the internationally recognized edge of space. [The space tourists will] help extend the legacy of space explorers who have come before [them], while pioneering access to the space frontier for all". The space tourists can enjoy the "largest windows in spaceflight history" and can "[be immersed] in the vastness of space and life-changing views of [the] blue planet".[259] The main engine will cut off and the passengers will "experience the freedom of weightlessness".[260]

Swiss Space Systems, ("S3"), has a mission to "[shape] the future of commercial space and academic space research" and foresees becoming "the world-leader in in-orbit

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[254] XCOR Space Expeditions, "The Flight" online: XCOR Space Expeditions <http://spaceexpeditions.xcor.com/the-flight/>.
[255] *Ibid.*
[256] *Ibid.*
[257] *Supra* note 252.
[258] Blue Origin, "Astronaut Experience" online: Blue Origin LLC <https://www.blueorigin.com/astronaut-experience>.
[259] *Ibid.*
[260] *Ibid.*

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delivery of small satellites".[261] S3's "objective is to develop, manufacture, certify and operate unmanned suborbital spaceplanes for small satellite deployment". [262] S3 "proposes a sustainable system built on aeronautics experience and developments", and boasts that they are "building the most economic and ecological model available today".[263]

The S3 system is comprised of an Airbus A330 aircraft which is "Zero-G certified" and configured for mid-air launches; and the spaceplane from which the satellites will be deployed. Once the aircraft reaches the height of approximately 10 kilometers, the spaceplane will launch from the A330 and will continue its atmospheric flight up to approximately 80 kilometers where the satellites will be launched. The spaceplane then returns to earth, "with no fuel required after landing a suborbital flight". [264] S3 has begun "testing and validating avionics systems, drone systems, Guidance-Navigation-Control instruments and various sensors" [265] in the city of North Bay, Ontario, Canada, and has plans for a future drop-test flight campaign of a fully functional, but reduced-scale SOAR suborbital shuttle mock-up, scheduled to take place in the spring of 2015 from the same location".[266]

Intercontinental Rocket Transportation

The Institute of Space Systems at the German Aerospace Center (DLR) proposes "a new kind of high-speed transport based on a two-stage reusable launch vehicle" to be called "SpaceLiner".[267] SpaceLiner's launcher technologies "could be very attractive for

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[261] Swiss Space Systems, "Mission & Goals" online: Swiss Space Systems <http://www.s-3.ch/en/mission-goals>.
[262] Up to 250kg small satellites: *ibid.*
[263] *Ibid.*
[264] *Ibid.*
[265] Swiss Space Systems, News Release "S3 Completes 1st Phase Drop-Test Flight Campaign in North Bay" (10 November 2014) online: S3 <http://www.s-3.ch/en/home/2014/11/10/s3-concludes-1st-phase-drop-test-flight-campaign-in-north-bay>.
[266] However, as of August 2015, no such flight test has been reported: *Supra* note 261.
[267] DLR Institute of Space Systems, "The SpaceLiner Vision" online: DLR <http://www.dlr.de/irs/en/desktopdefault.aspx/tabid-7679/>.

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long distances ([more than] 9,000 km) by allowing significantly reduced fight times".[268] Passengers on the SpaceLiner will rocket vertically to approximately 75 to 80 kilometres, a trip that takes approximately eight (8) minutes, where the SpaceLiner can reach hypersonic speeds of more than 25, 200 kilometres per hour and will transit from Europe to Australia in about ninety minutes.[269]

The ultra-fast transportation system provides an alternative to low-speed, multi-hour air travel. While the market may seem small at this time, DLR believes that

> even in the case that only a very small portion of the upper business-travel segment could be tapped by the SpaceLiner, production rates of RLVs and their rocket engines could increase hundredfold which is out of reach for all other known earth-orbit space transportation system concepts. The fast, intercontinental travel application of space technology would not only attract the business- and leisure market, would, as a byproduct, also enable to considerably reduce the cost of space transportation to orbit.[270]

Space Adventures

Another commercial space transportation provider is Space Adventures Ltd., which "is the world's premier private spaceflight company" and is currently the only provider of space tourism opportunities. Space Adventures "demonstrate[s] that space is no longer the domain of just the professional astronauts", and has "curated a suite of private spaceflight experiences to suit all interest levels and budgets".[271] Space Adventures also offers ZERO-G weightless flights and space flight training for those who may not be quite ready to make the trip.[272] Their ultimate mission is "to open spaceflight and the space frontier to private citizens".[273]

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[268] *Ibid.*
[269] Jeremy Hsu & TechNewsDaily, "Hypersonic "SpaceLiner" Aims to Fly Passengers in 2050", *Scientific American* (24 January 2013) online: ScientificAmerican.com <http://www.scientificamerican.com/article/hypersonic-spaceliner-aim/>.
[270] *Supra* note 267.
[271] Space Adventures Ltd, "Experiences" online: Space Adventures <http://www.spaceadventures.com/experiences/>.
[272] *Ibid.*
[273] Space Adventures Ltd., "About Us", online: Space Adventures Ltd. <http://www.spaceadventures.com/about-us/>.

Space Adventures offers suborbital spaceflight, and will fly spaceflight passengers 100km above the earth into space. There, they will and view the earth from space experience a few moments of weightlessness before returning to earth. Space Adventures boasts that this voyage of a lifetime is offered at a "relatively affordable price".[274]

Space Adventures' description of a space tourist's suborbital spaceflight adventure is particularly compelling:

> Suborbital space is a destination like no other – 10 times higher than the altitude reached by a commercial aircraft, and a third of the way to man's only orbital outpost – the International Space Station. You are in space. The view is spectacular – you can see the curvature of the Earth and see for hundreds of miles in any direction. Above you, the sky is no longer sky; it is space, and it is black. And getting there will be a thrill in itself.
>
> Imagine walking to the launch pad and gazing up at your rocket. Your mind casts back to photos you have seen of Yuri Gagarin and Alan Shepard; and you think of yourself in their shoes and how they must have felt. You are comforted by the knowledge that what you are about to do is not as reckless, but is on the cutting edge of space technology. Then, with the help of the launch team, you strap yourself in and wait calmly for the traditional countdown.
>
> Your pulse quickens as you realize that your dreams are about to come true. You are about to launch to space.
>
> 5…4…3…2…1… Blast off! The engines fire and you feel the gentle roar. You gracefully lift off and then the raw power below kicks in and you accelerate upwards. Just like they said… you feel heavier and heavier and it's hard to move your limbs, as you are pushed back into your seat. Wow, this is fun….
>
> The engines burn non-stop for two minutes. The sky races past you and it turns darker and darker. The engines shut down and you are surprised by the peace and quiet. You feel yourself gently

[274] The price, however, is not publicized. Space Adventures Ltd, "Suborbital Spaceflight" online: Space Adventures Ltd <http://www.spaceadventures.com/experiences/suborbital-spaceflight/>.

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> lift up as you start to float. You have reached space – and you'll wish you could stay there forever!

For those that want to go even further, Space Adventures also offers a "circumlunar expedition". Those are, in other words, flights to the Moon. The demand for lunar flights dates back to 1968. Airlines like Pan Am began to foresee the ability for laypersons to participate in the mystique and possibility of outer space and planned to take their passengers to the moon. By 1985, Pan Am had 90,002 reservations for its future flights to the moon,[275] notwithstanding that the last time humans set foot upon the moon was in 1972.[276] While commercial flights to the moon are not yet possible, the space industry is a far cry from what it once was and Space Adventures expects that flights to the moon might begin as early as 2018.[277] Therefore, this type of spaceflight should be in the contemplation of those establishing regulations as a forward thinking goal.

Hotels in outer space may sound to be an idea that is light years away, but in reality this form of space tourism was the first type of space tourism, and continues to exist today. The International Space Station is the original "Space Hotel". Space Adventures has organized visits for several space tourist's to the International Space Station, beginning with American citizen Dennis Tito in April 2001. This shows a market for a type of space hotel for those who wish to get the full experience of what life in space is like. The goal of the first space hotel has been realized and a functioning space hotel does exist! There are no mints on the pillows, or gourmet meals, and space hotel

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[275] Robert E. Dallos, "Pan Am Has 90,002 Reservations: Public Interest Grows in Flights to the Moon", *LA Times* (February 10 1985) online: <http://articles.latimes.com/1985-02-10/business/fi-3559_1_public-interest>.
[276] Space Adventures, "Circumlunar Mission", online: Space Adventures <http://www.spaceadventures.com/experiences/circumlunar-mission/>.
[277] *Ibid.*

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guests are expected to participate in experiments, but the views from this hotel are "simply out of this world" and will remain engrained in guests' minds forever.[278]

Anousheh Ansari was the first woman to travel privately in space. She spent ten (10) days aboard the ISS. In that time she listened to music, participated in experiments, and most importantly spent a lot of time looking out the large windows.[279] A self-fulfilling moment when Anousheh returned to earth and her mother presented her with a very special item. It was a frame that contained two images. The first, Anousheh drew when she was just a little girl imagining what it might be like to blast off into space. The crayon lines show a long space ship blasting off into the galaxy with stars around and flames coming from the rocket. The second image was a photograph taken by Anousheh's mother of the rocket that carried Anousheh to the International Space Station, blasting off. The two images are eerily similar, and show how the "dreams of a child do sometimes come true, no matter how outrageous or impossible the dream may be".[280] There have been at least seven other space tourists who have spent time in the International Space Station's "Space Hotel",[281] and Space Adventures' space tourists have "cumulatively spent close to three months in space and travelled more than 36 million miles".[282]

Life on Mars

A company called Mars One has begun soliciting applications from the curious and adventurous that will give up their life on earth and fulfill "Mars One's goal to establish a permanent human settlement on Mars".[283] It is expected that the first crews

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[278] Anousheh Ansari, "Come Meet Anousheh Ansari: The First Female Private Space Explorer" (Student Workshop delivered at the International Space Development Conference, Toronto, Ontario, 22 May 2015) [unpublished].
[279] *Ibid.*
[280] *Ibid.*
[281] *Supra* note 7 at 8.
[282] *Supra* note 273.
[283] Mars One, "About Mars One" online: Mars One < http://mars-one.com/en/about-mars-one/about-mars-one>.

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will depart for their one-way journey by 2026.[284] After the first crew is launched, further crews will settle on Mars every two years thereafter. Over 200,000 applications were received for the "first crew selection procedure", [285] showing the interest and the market for this type of activity. Of those, 100 applicants were eventually chosen to go on to a "group challenges" screening, whereby the potential crews will be exposed to "dynamic challenges" in small groups of 10-15 candidates over the course of five days.[286] "Following the challenges, the Mars100 will be screened to 40 candidates that will enter the next selection phase: isolation".[287] They "will spend nine days in an isolation unit" in order to ascertain their suitability for "prolonged close contact with one another".[288] Thirty candidates will be chosen for the final phase of the selection process, which is the "Mars Settler Suitability Interview (MSSI)".[289] The MSSI "measures suitability for long duration space missions and Mars settlement".[290]

Space Hotels

Bigelow Aerospace is in the business of private space habitat and is capitalizing on the market of those who wish to get a fuller experience and feel what it is like to actually live in Space. Since 1999, their mission has been "to provide affordable destinations for national space agencies and corporate clients".[291] Bigelow Aerospace launched two inflatable unmanned modules, Genesis-I and Genesis-II, which are experimental orbiting prototypes for their future "space hotel". Bigelow Aerospace has a number of "affordable options" for governments and commercial entities to take

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[284] See generally Mars One, "About Mars One" online: Mars One < http://mars-one.com/en/about-mars-one/about-mars-one>; "Mission and Vision" online: Mars One < http://mars-one.com/en/mission/mission-and-vision>; "Is This Really Possible" online: Mars One <http://mars-one.com/en/mission/is-this-really-possible >.
[285] *Supra* note 283.
[286] Mars One, Press Release, "Mars One Presents More Details on Next Astronaut Selection Rounds" (14 July 2015) online: Mars One < http://www.mars-one.com/news/press-releases/mars-one-presents-more-details-on-next-astronaut-selection-rounds>.
[287] *Ibid.*
[288] *Ibid.*
[289] *Ibid.*
[290] *Ibid.*
[291] Bigelow Aerospace, "About" online: Bigelow Aerospace <http://bigelowaerospace.com/about/>.

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advantage of the extraordinary opportunities to improve image, create jobs and improve economy, as well as presenting opportunities for corporations to gain significant advantages over the competition.[292] Bigelow explains that "the key to unlocking the potential of such opportunities is affordability", before noting that the per seat rate for "astronaut flight costs… per seat rate will be either $26.25 million or $36.75, depending on the transportation provider selected by the client".[293]

The "game changing" B330 is Bigelow's (and the world's) "first private space habitat".[294] Bigelow has developed an "expandable space habitat" that offers 330 cubic metres of internal volume and can support a crew of six.[295] Private entities will be able to lease square footage on the "B330" space habitats in order to conduct research, development, and/or other experiments. Clients can lease "exclusive use and control over approximately 110 cubic metres of volume".[296] Sixty-day leases for space habitat space starts at the low price of only $25 Million.[297] Clients can also lease the same amount of space in a larger "Alpha Station" at the rate of $51.25 Million.[298] The lease rates do not include the per seat astronaut flight costs, noted above. The space habitats can also be used for advertising or marketing, as companies may even purchase the right to name the "Alpha Station" for one year at a cost of $25 Million, or for half a year at a cost of $12.5 Million.[299]

Bigelow has entered into a partnership with NASA to "to develop ambitious human spaceflight missions that leverage its innovative B330 space habitat".[300] The B330

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[292] Bigelow Aerospace, "Opportunities & Pricing" online: Bigelow Aerospace <http://bigelowaerospace.com/about/opportunities-pricing-services/>.
[293] *Ibid.*
[294] Bigelow Aerospace, "B330" online: Bigelow Aerospace <http://bigelowaerospace.com/b330/>.
[295] *Ibid.*
[296] *Supra* note 292.
[297] *Ibid.*
[298] *Ibid.*
[299] *Ibid.*
[300] Bigelow Aerospace, "Bigelow Aerospace and NASA Execute NextSTEP Contract to Study B330 Utilization", News Release (31 July 2015) online: Bigelow Aerospace <http://bigelowaerospace.com/nextstep-announcement/>.

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will initially be deployed in the Low Earth Orbit ("LEO") where it will be tested for suitability to implement NASA's Beyond LEO Plan.[301] The B330s will also be used as private space stations for an assortment of commercial purposes.[302] On the occasion of the public announcement, President and CEO of Bigelow Aerospace, Robert T. Bigelow said:

> We're eager to work with NASA to show how B330s can support historic human spaceflight missions to the Moon and other destinations in cislunar space while still staying within the bounds of the Agency's existing budget…NASA originally conceived of expandable habitats decades ago to perform beyond LEO missions, and we at Bigelow Aerospace look forward to finally bringing that vision to fruition.[303]

Bigelow Aerospace has also developed a "Bigelow Expandable Activity Module" ("BEAM"). Just as the name describes, a BEAM is an expandable module that can be berthed to a space station.[304] Once safely berthed, "station crew will activate a pressurization system to expand the structure to its full size using air stored within [a] packed module".[305] NASA has awarded a $17.8 Million contract to Bigelow to provide a BEAM that will be added on as an addition to the ISS' Tranquility Node. Once in place, the BEAM will "use the orbiting laboratory to test expandable space habitat technology".[306] Celebrating the announcement, NASA Deputy Administrator Lori Garver said:

> Today we're demonstrating progress on a technology that will advance important long-duration human spaceflight goals…NASA's partnership with Bigelow opens a new chapter in our continuing work to bring the innovation of industry to space, heralding cutting-edge technology that can allow humans to thrive in space safely and affordably.[307]

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[301] See: Doug Cooke, Associate Administrator for Exploration Systems Mission Directorate, "Plans for Human Exploration Beyond Low Earth Orbit" (4 March 2011) online: NASA <http://www.nasa.gov/pdf/524774main_COOKE.pdf>.
[302] *Supra* note 300.
[303] *Ibid.*
[304] Bigelow Aerospace, "BEAM" online: Bigelow Aerospace <http://bigelowaerospace.com/beam/>.
[305] *Ibid.*
[306] *Ibid.*
[307] *Ibid.*

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Space Shuttles

SpaceX is proving that commercial service providers can assist National space activities by providing services to National governments. "SpaceX designs, manufactures and launches advanced rockets and spacecraft. The company was founded in 2002 to revolutionize space technology, with the ultimate goal of enabling people to live on other planets".[308] SpaceX is using FAA licenses to deliver supplies to the International Space Station,[309] and is the only private company ever to attach to the ISS to deliver cargo and return safety from space. SpaceX has a $1.6 Billion contract with NASA to fly numerous cargo resupply missions to the ISS. Their rocket, Falcon 9, "made history in 2012 when it delivered Dragon into the correct orbit for rendezvous with the International Space Station…[s]ince then SpaceX has made a total of seven flights to the space station, both delivering and returning cargo for NASA".[310] Additionally, SpaceX is developing means to bring crew to the ISS[311] through the development of the "Falcon Heavy", which will "be the most powerful operational rocket in the world by a factor of two".[312] SpaceX boasts that the "Falcon Heavy was designed form the outset to carry humans into space and restores the possibility of flying missions with crew to the Moon or Mars".[313]

While SpaceX has had many great successes, it has also experienced failure. SpaceX launched its seventh cargo mission to the ISS on June 28, 2015. However, 139 seconds after lift-off, the vehicle "experienced a problem shortly before first stage shutdown, resulting in loss of mission".[314] Unfortunately, this was not the first setback for resupply missions to the ISS, as the ISS experienced two other resupply flight failures (by Oribital ATK's Antares rocket, and Russia's unmanned Progress 59 vessel, respectively)

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[308] SpaceX, "About" online: SpaceX <http://www.spacex.com/about>.
[309] *Supra* note 162.
[310] SpaceX, "Falcon 9" online: SpaceX <http://www.spacex.com/falcon9>.
[311] *Supra* note 162.
[312] SpaceX, "Falcon Heavy" online: SpaceX <http://www.spacex.com/falcon-heavy>.
[313] *Ibid.*
[314] SpaceX, News Release, "CRS-7 Launch Update" (28 June 2015) online: SpaceX <http://www.spacex.com/news/2015/06/28/crs-7-launch-update>.

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in the eight months preceding the third failure.[315] This just goes to prove the volatile nature of the industry.

Virgin Galactic

As one of the earliest promulgators of commercial spaceflight, the history of Virgin Galactic's development shows the progression of suborbital spaceflight. The purpose of Virgin Galactic "is to become the spaceline for Earth; democratizing access to space for the benefit of life on Earth".[316]Accordingly, an in-depth analysis of Virgin Galactic is appropriate to demonstrate the birth of the industry, the workings of government regulation, and unfortunate tragedies associated with flight testing these new systems.

XPRIZE

The birth of Virgin Galactic came about after an XPRIZE competition in 2004. An XPRIZE is "a highly leveraged, incentivised prize competition that pushes the limits of what's possible to change the world for the better. It captures the world's imagination and inspires other to reach for similar goals, spurring innovation and accelerating the rate of positive change".[317] There are many different types of XPRIZE. In order to meet the criteria to establish an XPRIZE competition, there must be a "bold and audacious"[318] (but "achievable")[319] goal, "focused on problems currently believed to be unsolvable".

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[315] Mike Wall, "SpaceX Rocket Explodes During Cargo Launch to Space Station", *Space.com* (28 June 2015), online: Space.com <http://www.space.com/29789-spacex-rocket-failure-cargo-launch.html>.

[316] Virgin Galactic, "Human Spaceflight", online: Virgin Galactic <http://www.virgingalactic.com/human-spaceflight/>.

[317] XPRIZE, "What is an XPRIZE?" online: XPRIZE <http://www.xprize.org/about/what-is-an-xprize>.

[318] The "Bold and Audacious Goal" criteria requires that the project "[p]ushes the boundaries of human potential by focusing on problems currently believed to be unsolvable, or that have no clear path toward a solution": *ibid.*

[319] The "Audacious But Achievable" requires that "[w]hile a competition must be be bold and difficult, it must be achievable to ensure that teams believe that they can win": *ibid.*

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Further, the goal must "target a range of market failures"[320] and "define the problem vs. the solution".[321] It must be capable of being won in a "reasonable time frame",[322] by a small team that could be made up of individuals "ranging from industry experts to well-funded high school students who don't know what they can't do".[323] The competition must have "Clear, Objective, and Simple Rules",[324] and be "telegenic and easy to convey".[325] It must also be a good investment. The proposed XPRIZE competition must be "leveragable",[326] "drive investment", and "Create Back End Business".[327] Arguably, the most important criteria is that the XPRIZE competition "inspires hope through [a] vision of a better future where winning teams are the proof that seemingly impossible problems can be solved."[328]

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[320] The "Target Market Failure" criteria requires that a competition "[t]argets a range of market failures: (1) no capital is being spent, (2) capital is being spent, but without the desired result, (3) no capital is being spent because nobody knows it's a problem, (4) the problem is known, but no one can imagine that it's not already being addressed, (5) No one is addressing because a solution is thought to be impossible": *ibid.*

[321] The criteria to "Define the Problem vs. the Solution" means that a competition must be "[s]olution-agnostic, defining the challenge and incentivizing teams around the world to find the most effective solutions": *ibid.*

[322] The XPRIZE is "[d]esigned to affect the foreseeable future, so a duration of two to seven years is essential to allow teams enough time to succeed, while ensuring momentum and that industry will not outpace the competition": *ibid.*

[323] "Winnable by a Small Team" means that the competition "[s]hould be able to be won by teams ranging from industry-experts to well-funded high school students who don't know what they can't do": *ibid.*

[324] "Clear, Objective and Simple Rules" means that the competition must have a "[c]learly defined finish line with easy- to-understand rules and goals that are measurable and understandable by all": *ibid.*

[325] "Telegenic and Easy to Convey" means that "[t]he winning of the competition itself is interesting and compelling, and has innate narratives that are able to be conveyed easily to audiences": *ibid.*

[326] The "Leveragable" criteria means that the competition "[p]rovides leverage for a sponsor's investment by driving additional support of a solution; by shifting risk from sponsors to competitors, prizes attract investments of capital and time from motivate participants, and when prize produce vetted solutions that can attract further investment": *ibid.*

[327] The "Drive Investment" criteria means that the competition must "[e]nable innovators to attract capital, support and team members". The creation of "Back End Business" means that the competition "[s]hould give birth to a new industry or transform/revitalize an existing one with long-lasting benefits": *ibid.*

[328] *Ibid.*

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Intended to galvanize space travel, [329] the first Ansari XPRIZE was funded by the Ansari family and is specific to suborbital spaceflight. The competition "challenged teams from around the world to build a reliable, reusable, privately-financed, manned spaceship capable of carrying three people to 100 kilometers above the Earth's surface twice within two weeks".[330] The Ansari XPRIZE "competition began with $2.5 million in seed money, which led to a $10 million prize purse".[331]

The $10 million Ansari XPRIZE was awarded to "the Mojave Aerospace Ventures team, led by famed aerospace designer Burt Rutan and his company Scaled Composites, with financial backing by Paul Allen. Scaled Composites, developed "SpaceShipOne" specifically for the XPRIZE. Scaled Composites' system was made up of two vehicles: The rocket, SpaceShipOne is "a three-place, high-altitude research rocket, designed for suborbital flights up to 100km"; and a carrier aircraft called "White Knight", which is "a manned twin-turbojet research aircraft intended for high altitude missions". [332] The configuration of the rocket, SpaceShipOne, "allows aircraft-like qualities for boost, glide, and landing" and it "converts (via pneumatic-actuated feather) to a stable, high-drag shape for atmospheric entry". [333] White Knight, the aircraft, becomes a mid-air launch pad from which SpaceShipOne is launched.[334] The system was fully "reusable and developed entirely through private funding". [335] SpaceShipOne "became the first-ever private vehicle to carry a human being into space, making international headlines and stunning a world that had largely written off commercial human spaceflight as pure science fiction" [336] when it was launched for the first time on

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[329] "SpaceShipOne Rockets to Success", *BBC News* (7 October 2005), online: <http://news.bbc.co.uk/2/hi/science/nature/3712998.stm>.
[330] Ansari XPRIZE, "Mojave Aerospace Ventures Wins the Competition That Started It All" online: Ansari XPRIZE <http://ansari.xprize.org/teams>.
[331] *Ibid.*
[332] Scaled Composites, "SPACESHIPONE & WHITE KNIGHT" online: Scaled Composites <http://www.scaled.com/projects/tierone/>.
[333] *Ibid.*
[334] *Ibid.*
[335] Virgin Galactic, "A Brief History of Human Spaceflight", online: Virgin Galactic <http://www.virgingalactic.com/human-spaceflight/history-of-human-spaceflight/>.
[336] *Ibid.*

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September 29, 2004. SpaceShipOne successfully completed the challenge on October 4, 2004, winning the $10 Million Ansari XPRIZE[337] and stimulating imaginations and investment from around the world.

SpaceShipTwo

Sir Richard Branson "grew up watching the the Moon missions, and dreamed of one day flying to space himself".[338] Following the successful demonstration of the potential for commercial spaceflight with the Ansari X-PRIZE, and backed by Sir Richard Branson's entrepreneurial spirit and unstoppable ambition, a partnership developed between Scaled Composites and the Virgin Group. The purpose of the partnership was to create a commercial version of the SpaceShipOne system, to be the world's first commercial "spaceline": Virgin Galactic.[339]

Scaled Composites built the first commercial versions of SpaceShipOne and WhiteKnight, appropriately named "SpaceShipTwo" and "WhiteKnightTwo".[340] A sister company to Virgin Galactic was formed to create "all future vehicles in [the] spaceline fleet", and was named "The Spaceship Company".[341] Modeling the original SpaceShipOne system, WhiteKnightTwo is a "custom-built, four-engine, dual-fuselage jet aircraft… designed to carry SpaceShipTwo… up to an altitude of [approximately] 50,000 feet", where the SpaceShip is launched in mid-air.[342] A rocket motor engages, and SpaceShipTwo zips up into the sky at a speed that is three and a half times the speed of sound. Passengers will experience a "thrilling, dynamic rocket ride, the dramatic transition to silence and to true weightlessness" before returning to earth and gliding onto

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[337] Ansari X-Prize, "SpaceShipOne Wins $10 Million X-Prize" (5 October 2004), online: X-Prize <http://ansari.xprize.org/news/spaceshipone-wins-10-million-xprize>.
[338] *Supra* note 27.
[339] *Ibid.*
[340] Virgin Galactic, "Our Vehicles: These are the Vehicles that Will Take You to Space", online: Virgin Galactic <http://www.virgingalactic.com/human-spaceflight/our-vehicles/>.
[341] *Ibid.*
[342] *Ibid.*

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the runway at the spaceport of departure.[343] SpaceShipTwo is designed to repeatedly carry as many as eight people (including two pilots) into space; and boasts a window-lined cabin that has been "designed to maximize safety and comfort", and features "custom-designed, articulated seats" in a cabin that is "designed for unfettered enjoyment of a large floating environment.[344]

Virgin Galactic advertises that all spaceflight participants will earn their "astronaut wings".[345] Spaceflight participants are provided with three days of "pre-flight preparation, bonding, and training onsite at Spaceport America, the world's first purpose-built commercial spaceport". [346] This is in order to "ensure that each astronaut is mentally and physically prepared to savor every second of the spaceflight".[347] This is in stark contrast to the normal process for astronaut candidate training, where NASA estimates the requisite training at two to three *years* before embarking on a space mission to become an astronaut.[348]

The life-changing experience of sub-orbital spaceflight comes at a price. A seat on SpaceShipTwo currently costs US$250,000.00, which must be "paid as an up front deposit".[349] While this seems like a costly price tag, roughly 700 individuals (ranging in age from 10 to 90) have signed up and paid deposits to become "future astronauts".[350] To

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[343] Virgin Galactic, "Your Flight to Space: This is How You Will Become An Astronaut", online: Virgin Galactic < http://www.virgingalactic.com/human-spaceflight/your-flight-to-space/>.
[344] *Supra* note 340.
[345] *Supra* note 343.
[346] Virgin Galactic, "Astronaut Training: This is How You Will Prepare for Space", online: Virgin Galactic <http://www.virgingalactic.com/human-spaceflight/training/>.
[347] *Ibid.*
[348] National Aeronautics and Space Administration, "Astronaut Candidate Program", online: NASA <http://astronauts.nasa.gov/content/broch00.htm>.
[349] Virgin Galactic, "Fly With Us: Ready to Become an Astronaut?", online: Virgin Galactic <http://www.virgingalactic.com/human-spaceflight/fly-with-us/>.
[350] Virgin Galactic, "Why We Go: Exploring Space Makes Life Better on Earth", online: Virgin Galactic <http://www.virgingalactic.com/why-we-go/>.

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put the demand into perspective, that is more than the number of people that have ever been to space before, which is approximately 549 persons.[351]

Catastrophe and Accident Investigation

Virgin Galactic suffered a serious setback on October 31, 2014 when Scaled Composites' SpaceShip Two, which was to be Virgin Galactic's spacecraft, broke up thirteen (13) seconds into its fourth powered test flight. The spacecraft was destroyed and the pilot was seriously injured. The co-pilot was fatally injured. Thankfully, there were no injuries on the ground. SpaceShip Two was operating under an experimental permit issued by the Federal Aviation Administration's Office of Commercial Space Transportation.[352]

The National Transportation Safety Board ("NTSB") is the US federal agency charged with determining probable cause of transportation accidents.[353] The NTSB conducted an investigation into the accident along with the parties involved, namely, Scaled Composites, Virgin Galactic, Federal Aviation Administration, and Butler Parachute Systems.[354] This was the first time that the NTSB investigated an accident involving a reusable suborbital rocket.[355] The NTSB's investigation began immediately after the accident and a "Go-Team" was deployed to the crash scene.[356] While the full technical specifications will not be described, SpaceShip Two has an important "feather" component that changes its aerodynamic configuration between the period of release from WhiteKnight Two and atmospheric entry. The "feather" is locked in flight. The

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[351] WorldSpaceFlight, "Astronaut/Cosmonaut Statistics", online: WorldSpaceFlight <http://www.worldspaceflight.com/bios/stats.php>.
[352] National Transportation Safety Board, "Investigator-in-Charge Presentation" *Board Meeting: Commercial Space Launch Accident – SpaceShip Two*, online: NTSB <http://www.ntsb.gov/news/events/Documents/2015_spaceship2_BMG_IICpresentation.pdf>.
[353] National Transportation Safety Board, Press Release, "NTSB Launches Go-Team to Investigate Virgin Galactic Test Flight Crash" (October 31 2014) online: NTSB <http://www.ntsb.gov/news/press-releases/Pages/PR20141031.aspx>.
[354] *Supra* note 352.
[355] *Ibid.*
[356] *Supra* note 353.

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feather needs to be unlocked by the co-pilot once SpaceShip Two reaches a speed of 1.4 mach, approximately 26 seconds after reaching 0.8 mach. The co-pilot is responsible to call out when the SpaceShip reaches a speed of 0.8 mach, and then he is responsible to "unlock the feather" manually when the speed reaches 1.4 mach. If the SpaceShip reaches a speed of 1.8 mach before the feather is unlocked, the procedure is to immediately abort the flight.[357] Thus, the unlocking of the feather at the right time is crucial and critical to the success of the flight. There are no automated cockpit cues for the pilots reminding them what to do within the 26 second period of time, the pilots must memorize (and remember!) each of their tasks and the precise timing for execution. In this tragic case, the feather was unlocked early (i.e. before reaching 1.4 mach) by the co-pilot, which caused the catastrophic loss. The precise timing is not known, but it is important to note that the co-pilot had to execute his duties within twenty-six (26) seconds, so "early" in this context was mere seconds.

The NTSB's investigation revealed that,

> Scaled Composites did not emphasize human factors in the design, operational procedures, simulator training or hazard for SpaceShip Two. During design scale did not consider the possibility that a pilot would unlock the feather before 1.4 mach and as such no safeguards were built into the feather system to prevent this.[358]

The investigation further revealed that "although program personnel said that they were aware that unlocking [the feather] during transonic flight would be catastrophic, there was no warning, caution, or limitation in the pilot operating handbook or test card that specified this risk".[359]

Furthermore, the investigation revealed deficiencies with the application and approval process for the experiential flight permit. When SpaceShip Two began the

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[357] *Supra* note 352
[358] *Ibid.*
[359] *Ibid.*

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application process, it had already been designed and manufactured, which would have made proposed changes difficult and costly. The application process prescribes a 120-day review period after the application is received. Staff were under pressure to approve external applications with the 120-day review period, even if they believed technical data was still required to complete the review.[360] As part of the application process for an experimental flight permit, an applicant is required to conduct a hazard analysis to identify and characterize each of the hazards and asses the risk to public health and safety and the safety of property resulting from each permitted flight.[361] The hazard analysis must comply with the following provision that states, *inter alia*:

> §437.55 Hazard analysis.
> (a) A permittee must identify and characterize each of the hazards and assess the risk to public health and safety and the safety of property resulting from each permitted flight. This hazard analysis must—
> (1) Identify and describe hazards, including but not limited to each of those that result from—
> (i) Component, subsystem, or system failures or faults;
> (ii) Software errors;
> (iii) Environmental conditions;
> (iv) Human errors;
> (v) Design inadequacies; or
> (vi) Procedural deficiencies.
> (2) Determine the likelihood of occurrence and consequence for each hazard before risk elimination or mitigation.
> (3) Ensure that the likelihood and consequence of each hazard meet the following criteria through risk elimination and mitigation measures:
> (i) The likelihood of any hazardous condition that may cause death or serious injury to the public must be extremely remote.
> (ii) The likelihood of any hazardous condition that may cause major property damage to the public, major safety-critical system damage or reduced capability, a significant reduction in safety margins, or a significant increase in crew workload must be remote.[362]

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[360] *Ibid.*
[361] 14 CFR §437.29.
[362] 14 CFR §437.55.

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Specifically, the analysis must include the hazards relating to human error. The FAA provides guidance on how to undergo this hazard analysis and specifies that the analysis must address human errors, including:

> Decision errors, such as using flight controls at the wrong time;
> Skill-based errors, such as improperly following a procedure;
> Perceptual errors, such as spatial disorientation;
> Violations, such as a failure to adhere to abort procedures; and
> Organizational and supervisory factors, such as poor scheduling, inadequate or non-existent training, inadequate communications, or inadequate resources.[363]

Scaled Composites analyzed the hazards, and the FAA/AST determined that the analysis did not meet the requirements for software and human errors. Scaled Composites stated that it had not conducted a full analysis of these factors due to their use of "aircraft and spacecraft design redundancy, flight and maintenance procedures, and ground and flight crew training to mitigate against hazards caused by human and software errors".[364] Notably, the FAA/AST, on their own accord, issued a 'Notice of Waiver' for this requirement, which states:

> This notice concerns a waiver to Scaled Composites, LLC (Scaled) from the requirements of 14 CFR 437.29 and 437.55(a) to provide the FAA a hazard analysis that identifies, mitigates, and verifies and validates mitigation measures for hazards created by software and human error. The FAA finds that a waiver is in the public interest and will not jeopardize public health and safety, safety of property, and national security and foreign policy interests of the United States.[365]

It is important to emphasize that Scaled Composites did not apply for such a waiver, yet it was granted by the FAA/AST on their own accord.

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[363] US, Department of Transportation, Federal Aviation Administration, *Hazard Analyses for the Launch or Reentry of a Reusable Suborbital Rocket Under an Experimental Permit* (Advisory Circular No 437.55-1) (Washington, DC, April 20 2007).
[364] US, Federal Aviation Administration and the Commercial Space Transportation Office, *Waiver of 14 CFR 437.29 and 437.55(a) for Scaled Composites, LLC* (FR Doc. 2013-17169) (Washington, DC, July 9 2013).
[365] *Ibid.*

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Tragically, the NTSB's findings on probable cause determines that:

> [Scaled Composites'] failure to protect against the possibility that a single human error could result in a catastrophic error to this vehicle. This set the stage for the co-pilot's immature unlocking of the feather system, which led to un-commanded feather extension and dynamic overload and in-flight break up of the vehicle.[366]

This determination shows that a single human error was the cause of the accident. Had the FAA/AST fully enforced the conditions laid out for hazard analysis, and Scaled Composites fully realized the potential for human error, even with redundant technology, this accident may have been avoided.

The NTSB's investigation into the accident identified the following safety issues:

- Lack of human factors guidance for commercial space operators
- The efficiency and timing of the pre-application consultation process
- Limited interactions between the FAA and applicants between the experimental permit evaluation process
- Missed opportunities during the FAA/AST evaluation of Scaled Composite's hazard analysis and waiver from regulatory requirements
- Limited inspector familiarity with commercial space operators
- The need for improved emergency response planning
- The need for a fully developed database for commercial space operators on mishap lessons learned[367]

While it was the actions of the co-pilot that led to the demise of SpaceShipTwo and a significant setback in the industry, the actions of the FAA/AST in issuing a unrequested waiver are concerning. The NTSB found that it was Scaled Composites' failure to protect against human error. In fact, it was the government that specifically informed Scaled Composites that it did not need to comply with the regulations that would safeguard against this type of accident. Virgin Galactic has since examined the

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[366] *Supra* note 352
[367] *Ibid*.

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design of the SpaceShip and they have added an inhibitor to prevent the unlocking of the feather under certain conditions,[368] but the domestic legislation has not since changed.

This accident raises questions about a potential conflict of interest that was raised ten years prior to the accident, whereby scholars questioned whether the FAA should take on the role of both promoting and regulating the commercial space transportation industry. It was thought that it might be "more appropriate for the Department of Commerce rather than the FAA to freely promote the space tourism industry by focusing on the primary objective of generating economic revenue without the restriction of a conflict of interest".[369] At that time, it was noted "that in both aviation and maritime law the promotional and regulating authority vested in one entity was later withdrawn due to a conflict of interest".[370] Unfortunately in this case, it would appear that the FAA/AST was concerned about promoting the industry, which may be why they issued the waiver on their own accord. However, it is clear that the promotion of the industry at the expense of safety objectives is not appropriate and that the conflict of interest has, in fact, been realized as foreseen nearly a decade ago.

The commercial space transportation industry has ambitious goals, but must keep in mind the lessons learnt from accidents of the past, including Virgin Galactic's tragic accident in 2014. With a thorough appreciation of the scope of new technologies, it is possible to begin analysing the "black holes" in space law that need to be addressed as the industry blasts off.

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[368] *Ibid.*
[369] Melanie Walker, "Suborbital Space Tourism Flights: An Overview of Some Regulatory Issues at the Interface of Air and Space Law" (2007) 33 J Space L 375 at 398.
[370] US, USGAO, *Commercial Space Launches: FAA Needs Continued Planning and Monitoring to Oversee the Safety of the Emerging Space Tourism Industry* (GAO-07-16, 32) (October 2006) as cited in Melanie Walker, "Suborbital Space Tourism Flights: An Overview of Some Regulatory Issues at the Interface of Air and Space Law" (2007) 33 J Space L 375 at 398.

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Chapter Five: Black Holes

It doesn't take a rocket scientist to know that traveling to outer space is risky…although that is something that rocket scientists know very well. Historic examples of governmental spaceflight failures outline the volatile nature of the industry. More recent examples show how commercial entities are succeeding and failing at the same time. The development of the commercial space travel industry bears resemblance to the development of the railway, maritime, and aviation industries. "In the mid 1900's, the international community was faced with the challenge of developing regulations to govern the international aviation industry".[371] The solution to that challenge was to implement the *Warsaw Convention* and the *Chicago Convention.* It has been argued that "the international community would benefit from the development of a commercial liability treaty, similar to the Warsaw Convention, for commercial space travel".[372] This is due, in part, to the reality that the existing international space laws do not even consider commercial entities in space, which raises questions about the application of such laws to commercial entities. It is proposed that, without pre-emptive regulations that specifically target commercial space travel, specifically in relation to liability, the industry may flounder. There are negative economic implications and insurance ramifications that would ensue from a continued lack of regulation. Positive economic implications and insurance ramifications could ensue if there is greater certainty in the application of the law. However, a delicate balance needs to be struck as "over regulation would be potentially disastrous for the new industry".[373] Thus, a detailed analysis of the "black holes" of liability and lessons learnt from previous industries in order to develop an appropriate legal framework.

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[371] Ashleigh Tomlinson, "The Regulations of Emerging Mode of Aerospace Transportation: Challenges and Opportunities" (2013) 68:5 ICAO Journal 56 at 57.
[372] R Thomas Rankin, "Space Tourism: Fanny Packs, Ugly T-Shirts and the Law in Outer Space" (2002-2003) 36 Suffolk U L Rev 695 at 714.
[373] David Malfitano, "Space Tourism: The Final Frontier of Law" (2008-2009) 35 Rutgers Computer & Tech LJ 203 at 204.

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Liability

Where there is risk, there is liability. Some examples of situations that could give rise to damage and legal liability include, but are not limited to, injuries on board a spacecraft, collision with another space object, malfunction, or the accidental abandonment of a space traveller in space and/or total destruction of a spacecraft. Companies wishing to participate in commercial space transportation are working with the newest technologies, yet there are still many unknowns that are in play. Even the most sophisticated technology may fail if the right safeguards are not put in place. The industry must be ready for commercial space transportation, which applies equally to technological and legal advancements. The processes and space vehicles must be the safest that they can possibly be and a cohesive and comprehensive legal regime must be in place to insulate the whole project.

It may be helpful to examine a liability regime that assisted in the development of the aviation industry, in the hopes that a similar application would benefit the space industry. The first air law treaty creating rules for determining liability pre-empted the growth of the aviation industry. The international community came together and prepared the Convention that would help to establish and foster the growth of the aviation industry. The *Convention for the Unification of Certain Rules Relating to International Carriage by Air,* [374] signed at Warsaw in 1929 ("*Warsaw Convention"*), established a uniform liability regime applicable in the event of an accident on board an aircraft, or in the course of embarkation and disembarkation. Specifically, the *Warsaw Convention "*sought to establish a uniform system of strict but limited liability for air carriers in the event of international accidents involving passenger injury or death".[375]

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[374] *Convention for the Unification of Certain Rules Relating to International Carriage by Air*, 1929, 12 October 1929, 137 LNTS 11 [*Warsaw Covention*].
[375] Matthew R. Pickelman, "Draft Convention for the Unification of Certain Rules for International Carriage by Air: The Warsaw Convention Revisited for the Last Time?" (1998-1999) 64 J Air L & Com 273 at 279.

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It is believed that the *Warsaw Convention*, and the express limitations that it placed on liability, allowed the industry to grow without its development being stunted by high value claims against airlines. Scholars have noted, that "[i]t was hoped that the limitation would provide a favorable environment for the growth of the then infant international air transportation industry".[376] The *Warsaw Convention* guarantees recovery for a passenger upon proof of damage, and "assure[s] the financial liability of carriers".[377] A 'cap' is placed on the maximum quantum recoverable by each passenger in the event of an accident. The idea is that this cap would allow airlines to determine their maximum probable loss, and insulate them from crippling damage claims in the event of an accident.

A similar cap on liability would allow the commercial space travel industry to flourish in the same way as the aviation industry did. This would enable "[p]assengers, governments, and commercial operators… to know in advance of liability rules regarding passenger tours to outer space in order to make informed, calculated decisions about such travel".[378] Commercial space transportation service providers would be able to purchase insurance to cover the maximum probable loss ("MPL") associated with their activities in space more precisely. The establishment of a maximum probable loss would allow spaceflight operators to insure their operations up to a specific amount, rather then leaving liability open-ended. A cap would open the market to more players by allowing them to protect their business, but also allow new entrants to the market by providing legal certainty to financiers. This legal certainty is especially important in a high-risk venture where the participants are likely to have significant financial losses in the event of a catastrophic accident. Even if the liability was capped at, for example, $10 Million

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[376] Michael S. Gill, "Turbulent Times or Clear Skies Ahead?: Conflict of Laws in Aviation Delict and Tort" (1998-1999) 64 J Air L & Com 195; at 199, citing Kimberlee S. Cagle, "The Role of Choice of Law in Determining Damages for International Aviation Accidents" 51 J Air L & Com (1985) 953 at 955-956.
[377] *Ibid,* at 199.
[378] *Supra* note 372 at 714.

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dollars, having a set figure to establish the maximum probable loss is imperative to achieving financial certainty as to the risk involved in the venture.

Under the *Warsaw Convention,* air carriers are *prima facie* liable for death or bodily injury if it occurs "on board an aircraft or in the course of any of the operations of embarking or disembarking".[379] The carrier is also *prima facie* liable for damage to baggage or caused by delay in carriage.[380] The air carrier can absolve itself of liability if it can prove it took "all necessary measures to avoid the damage or that it was impossible for [it] to take such measures",[381] or if "the damage was caused by or contributed to by the negligence of the injured person".[382] A carrier is not able to absolve itself of liability if the damage is caused by the wilful misconduct of the carrier or its agents acting in the scope of their duties.[383]

The *Warsaw Convention* has evolved since 1929 with the development of the air transport industry and liability for international air transport is now determined subject to the provisions of the *Convention for the Unification of Certain Rules for International Carriage by Air*,[384] signed in Montreal in 1999 ("*Montreal Convention*"). In addition to the names of the Conventions being identical, the provisions of each are similar, with the exception of the quantum recoverable under the liability scheme. The *Warsaw Convention* is still in effect for those States that have not yet ratified the *Montreal Convention*. The two treaties together are known together as the *Montreal System.* Under international aviation law, the *Montreal System* provides exclusive remedies for those who suffer damage as a result of an air carrier engaged in international civil aviation. Neither the parameters of the *Montreal System*, nor the parameters of the *Liability*

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[379] Convention for the Unification of Certain Rules Relating to International Carriage by Air, 1929, 12 October 1929, 137 LNTS 11, Art 17 [*Warsaw Convention*].
[380] *Warsaw Convention*, arts 18-19.
[381] *Warsaw Convention*, art 20.
[382] *Warsaw Convention,* art 21.
[383] *Warsaw Convention*, art 25.
[384] Convention for the Unification of Certain Rules for International Carriage by Air, 28 May 1999, 2242 UNTS 309 [*Montreal Convention*].

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Convention cover, or even touch, the field of liability for commercial space transportation.

The *Montreal System* only applies to aircraft engaged in international air transportation, and thus excludes space transportation systems. However, with the type of space vehicles being designed and operated, it is possible that a space vehicle could have components of both an aircraft and a spacecraft. Furthermore, that vehicle will inevitably travel through air space. A clear definition between air space and outer space is required "[i]f different liability rules will apply to air travel and space travel, then all concerned parties should know where airspace ends and where outer space begins".[385]

The *Liability Convention* was written at a time when only governments were engaging in space activities, and places liability squarely on the shoulders of the government who approved the space activity, regardless of whether or not it was governmental or commercial activity. States are responsible for any damage caused by their space objects. This is a well established general principle of law and codified in Article VII of the *Outer Space Treaty*, the *Liability Convention*, and Article 14(2) of the *Moon Agreement*.[386]

The fact that a State is absolutely liable and responsible under international law to pay compensation for damage caused by not only its own governmental activities, but also for the commercial activities of its nationals, and for objects launched from their territory, could attract more claims than have ever been seen before as the space race extends to commercial players. This is not a high threshold, because there has only been one claim with respect to liability for damage to a State due to the space activities of another State. A classification of a Space activity as "national activities" carried out by States or their entities will activate the provisions of the *Outer Space Treaty*. Such activities are the international responsibility of the 'national' State, and the activities are

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[385] *Supra* note 372 at 714 [footnotes omitted].
[386] *Moon Agreement*, art 14(2).

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subject to the authorization and continuous supervision of the 'appropriate' State.[387] The 'launching' State bears internationally liability for the activities.[388] These are hard law principles embodied in the framework of international Space law, and reflect customary international law and thus bind all States, regardless of the status of ratification of the treaties.[389]

These issues have arisen in the context of States engaging in Space activities on their own behalf, and have been solved by cross-waivers of liability and other legal agreements between States. However, the framework becomes convoluted when faced with the prospect of four or five possible 'appropriate' States that are supposed to continuously supervising. The *Outer Space Treaty* does not define the term 'continuous supervision', nor provide parameters for how a State might supervise activities in Space. The lacuna in international space law is the inability to determine the appropriate State: it could be a black hole of liability if this issue is being grappled with after an accident. This black hole must be filled in order to create legal certainty.

The only dispute that has arisen under the *Liability Convention* is the COSMOS-954 accident. On January 24, 1978, COSMOS-954, a Soviet nuclear powered surveillance satellite crashed in the Northwest Territories, Canada, scattering radioactivity over 124,000 square kilometres.[390] Canada raised a claim against the former USSR for damage caused by the Soviet Cosmos-954 accident. Canada stated that the USSR was absolutely liable to pay compensation because "the deposit of hazardous radioactive debris on Canadian territory, and the presence of the debris in the environment rendering part of Canada's territory unfit for use, constituted damage to

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[387] *Outer Space Treaty*, art IV.
[388] *Outer Space Treaty*, art VIII.
[389] Steven Freeland, "Up, Up and…Back: The Emergence of Space Tourism and Its Impact on the International Law of Outer Space" (2005-2006) 6 Chi J Int'l L 1 at 16.
[390] Health Canada, "The COSMOS 954 Accident" online: Health Canada <http://www.hc-sc.gc.ca/hc-ps/ed-ud/fedplan/cosmos_954-eng.php>.

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property within the meaning of the Convention."[391] The USSR agreed to pay $3,000,000 "in full and final settlement of all matters connected with the disintegration of the Soviet satellite Cosmos-954 in January 1978". [392] In this case, the claims commission contemplated by the *Liability Convention* was not formed, as the parties were able to resolve the dispute using diplomatic channels.

As mentioned above, States bear international responsibility for activities of both government and non-government entities, and non-governmental entities must be authorized and supervised by the State.[393] Furthermore, States that launch a space object, procure the launch of a space object, or from whose territory a space object is launched bear international responsibility for any damage caused by that space object. Article VII of the *Outer Space Treaty* states:

> Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the Moon and other celestial bodies, and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the Moon and other celestial bodies.[394]

Furthermore, the *Liability Convention* states:

> A launching State shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft in flight.[395]

The term 'launching State' means either a State that launches or procures the launching of a Space object or a State from whose territory or facility a space object is launched.[396] With the increasing number of private entities engaging in space activities, it

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[391] Bess C.M. Reijnen, *The United Nations Space Treaties Analysed,* (Utrecht, The Netherlands: Editions Frontieres, 1992) at 185 citing ILM 1979, 18, pp 899f.
[392] *Ibid* citing Article II of the Protocol on Cosmos-954, of April 2, 1981; ILM 1981 p. 689.
[393] *Outer Space Treaty*, art VI.
[394] *Outer Space Treaty*, art VII.
[395] *Liability Convention,* art II.
[396] *Liability Convention,* art I(c).

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is not so clear-cut who are the 'national State', the 'appropriate State' and the 'launching State'.

When damage is caused elsewhere then on the surface of the earth, States Parties have fault-based liability.[397] This is due, in part, to the fact that in space the two States Parties are involved in high-risk adventures so, presumably, they have more capabilities than those on the ground to prove fault. By contrast, when any damage is caused to the earth, States Parties have absolute liability.[398] The legislative intent is to protect the weaker party and let the stronger party, or that of equal technical capability, discharge the burden of proof.

Apportionment of any damage caused on earth favours the injured party and allows that party to claim compensation jointly and severally from any launching State(s) of the damage-causing object.[399] A State party can only be exonerated of absolute liability if they are successful in proving that "the damage has resulted wither wholly or partially from gross negligence or from an act or omission done with intent to cause damage on the part of a claimant State or of natural or juridical persons it represents".[400] The threshold is higher than simple negligence under general domestic law or the general standard of the general principle of law. However, if the State Party is in violation of international law, it shall not be exonerated.[401]

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[397] *Liability Convention*, art III.
[398] *Liability Convention*, art II.
[399] Article IV(2) of the *Liability Convention* states: "In all cases of joint and several liability referred to in paragraph 1 of this article, the burden of compensation for the damage shall be apportioned between the first two States in accordance with the extent to which they were at fault; if the extent of the fault of each of these States cannot be established, the burden of compensation shall be apportioned equally between them. Such apportionment shall be without prejudice to the right of the third State to seek the entire compensation due under this Convention from any or all of the launching States which are jointly and severally liable": *Liability Convention,* art IV (2).
[400] *Liability Convention*, art VI(1).
[401] *Liability Convention*, art VI(2).

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There are lacunae in the current international regime,[402] particularly in the *Liability Convention* and the *Rescue Agreement*. At this stage, neither corporations nor space passengers would have standing to bring a claim within the *Liability Convention* if they suffer damage. Furthermore, these spacecraft used for commercial space travel may not fall within the ambit of the *Rescue Agreement*, which would cause serious hardship should they find themselves in distress outside of the earth's atmosphere.[403] A further downfall of the *Liability Convention* is that it does not have a cap on liability.

Space Insurance

The reality is that States are responsible for all acts of their nationals in outer space. Therefore, most States require their nationals to obtain insurance before being permitted to participate in space faring activities. In the US for example, the State requires their space faring nationals to have an insurance policy that would cover a maximum probable loss. The difficulty in arriving at a maximum probable loss when one is dealing with the carriage of passengers, as opposed to governmental astronauts, is particularly complex.

A significant limitation to the growth of the space travel industry is the cost. Clarity of liability laws establishing a "cap" on international liability would benefit passengers and operators alike by allowing operators to determine their maximum liability and insure their services accordingly, rather than inflating prices in order to cover the potential liability that may arise in the event of an accident or incident. A liability regime which places a limitation on liability will allow more companies to participate in this industry, which will have positive economic implications and foster competition. This will decrease prices and allow more passengers access to the industry.

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[402] *Supra* note 7.
[403] *Rescue Agreement.*

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A major hurdle to the development of the space travel industry is the potential for exposure to third party liability.[404] The *Liability Convention,* in particular, is significantly lacking as commercial space transportation evolves. The *Liability Convention* reads that States shall bear absolute liability for any damage cause, subject to the limitations about exoneration, as noted above. However, the *Liability Convention* also states that its provisions "shall not apply to damage caused by a space object of a launching State to [n]ationals of that launching State," or to invited foreign nationals.[405] Thus, the provisions of the *Liability Convention* may not cover anyone who is voluntarily participating in the space activity and the treaty can be interpreted in such a way that States will not bear absolute liability for damage caused to those persons. Conversely, the *Liability Convention* does not address private entities whatsoever. It has been suggested, therefore, that "private entities have neither any recourse nor accountability under the Outer Space Treaty and the Liability Convention".[406]

When the projected participants in spaceflight were all governmental astronauts, this provision made common sense as those astronauts were, presumably, all employees of the State. The launching State would already, through various employment and insurance related statutes and policies, bear responsibility for their employed astronauts. When the space flight participant is a national of a State, but not an employee or otherwise engaged by the State, the fact that the *Liability Convention* does not apply to them is a significant gap that must be addressed as this industry grows.

The US Government attempted to help promulgate the development of US space travel by implementing an in indemnification scheme for excess third party liability. In 1988, the United States adopted their commercial space launch indemnification program, recognizing that an accident in the early stages of development could have a huge impact.

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[404] *Supra* note 244 at 9.
[405] *Liability Convention,* art VIII.
[406] Zhao Yun, "A Legal Regime for Space Tourism: Creating Legal Certainty in Outer Space" (2009) 74 J Air L & Com 959 at 966.

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The regime is a three-tiered system, where the launch provider is responsible for the first and third tiers, and the government indemnifies the launch provider for the second tier.

For determination of the "first tier" licensees are required to analyze the risk involved in the space activity, and the FAA will determine the degree of financial responsibility required for the space activity based on the figure of "maximum probable loss", calculated by "reviewing the specific circumstances of the launch, including the planned launch vehicle, launch site, payload or cargo, flight path, and the potential casualties and fatalities that could result from varying types of launch failures at different points along that path". [407] That calculation defines the financial responsibility requirements for a space activity. This amount is determined based on "an analysis and assessment of the maximum monetary losses likely to be incurred by government and third party personnel and property in the event of a mishap. The MPL is a dollar value assessment of government and third party properties at risk of damage from launch-related activities or conduct". [408] MPL amounts increase with new technologies. Currently, the financial responsibility requirements for damage to third parties ranges from US$3 Million to US$261 Million.[409]

An issue is that estimating the maximum probable loss from rare catastrophic events is quite difficult. The amount and price of insurance could change quickly in the event of a catastrophic event. A study in July 2012 revealed that the FAA's method of calculating MPL was inaccurate, out-dated, and may not be sound.[410] Accordingly, the

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[407] US, Testimony Before the Subcommittee on Space, Committee on Science, Space and Technology, House of Representatives, 113th Cong, *Commercial Space Launches: FAA's Risk Assessment Process Is Not Yet Updated* (GAO-14-328T) (Washington, DC: United States Government Accountability Office, 2014) at 5.

[408] FAA Office of Commercial Space Transportation, "Launch Data and Information: Maximum Probable Loss" (30 April 2015) online: FAA/AST <http://www.faa.gov/about/office_org/headquarters_offices/ast/launch_license/mpl_values/>.

[409] FAA Office of Commercial Space Transportation, "Financial Responsibility Requirements as Determined by the Maximum Probable Loss (MPL) Process" (28 April 2015) online: FAA.gov <http://www.faa.gov/about/office_org/headquarters_offices/ast/launch_license/mpl_values/media/MPLApril2015.pdf>.

[410] *Supra* note 407 at 11-12.

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FAA agreed that a review and the involvement of independent experts could be beneficial.[411] As of January 2014, the FAA has taken steps to update the MPL methodology, but they do not have the budget to complete the work.[412] A comprehensive update to the MPL methodology has to weigh the benefit of same with the burden of increased costs to government agencies and launch companies.[413] However, the consequence of not updating the MPL is an inaccurate MPL value, which may "increase the cost to launch companies by requiring them to purchase more coverage than is necessary, or result in greater exposure to potential cost for the federal government"[414] under the second tier of indemnification.

The second tier comes into effect if there is a catastrophic accident where third party liability exceeds the insurance coverage or financial responsibility assumed by the space operator. In that case, the US government will indemnify the licensee for amounts exceeding the first tier of liability coverage, up to $1.5 billion, adjusted for inflation.[415] This approach was introduced in 1988, and was necessary "because of a Congressional determination that there was not sufficient insurance capacity available in the world insurance market at a reasonable cost to cover the worst-case, catastrophic event and that launch companies should not be asked to bet the company".[416] However, the indemnification scheme does not apply to experimental permits[417] nor to spaceflight participants.[418] Therefore, during the testing phase, which is presumably one of the riskiest launches due to the number of uncertainties, the indemnification scheme would

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[411] *Ibid*, at 13-14.
[412] *Ibid*, at 14.
[413] *Ibid*, at 26.
[414] *Ibid*, at 26.
[415] *Supra* note 244 at 9.
[416] Pamela L Meredith, "Commercial Space Transportation: Liability and Insurance" (Paper delivered at the McGill Institute of Air and Space Law Air Transport, Air & Space Law and Regulation Workshop and Conference, Abu Dhabi (UAE) 16 April 2009) at 3, online: McGill IASL <https://www.mcgill.ca/iasl/files/iasl/Session_7_Meredith.pdf>, citing US, Senate Committee on Commerce, Science, and Transportation, 100th Cong. *Commercial Space Launch Amendments 1988, Report of the Senate Committee on Commerce, Science, and Transportation on HR 4399* (S Rep No 100-593) (Washington, DC: US Government Printing Office, 1988) at 9, 17.
[417] 49 USC §70113(f).
[418] 49 USC §70113(a).

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not assist commercial space transportation providers in the event of a catastrophic accident causing third party damage on the ground. Furthermore, the indemnification scheme applies only to third parties who are not participating in the space activity. It is suggested that "Federally mandated contractual waivers by spaceflight participants or liability caps would be helpful to complement insurance solutions. Eventually, as the industry matures, such practices could be extended to an international legal regime".[419]

The third tier of the indemnification regime is for claims exceeding the indemnification amount. Launch operators are responsible for any amounts over the amount indemnified by the federal government. Launch operators may purchase insurance to cover these amounts, but it is not a statutory requirement, unlike the first two tiers.[420]

In July 2012 comparing US indemnification against other countries resulted in a finding that the US provides less than China, France and Russia.[421] In those countries, a "two-tiered" indemnification regime applies, under which the government's indemnification has no limit after the commercial space providers' insurance requirements.[422] However, commitments to pay have never been tested because third party claims have never exceeded the amount of insurance coverage required under the first tier.[423] The analysis conducted by the Unites States, however, revealed that the US coverage may begin at a lower level due to the MPL calculations which determine the level at which government indemnification begins, as compared to the fixed levels at which indemnification begins in China, France, and Russia. It was found that Chinese indemnifies third party claims starting at $100 million, France at $60 million euros, and in Russia $80 million for smaller launch vehicles, and $300 million for larger launch

[419] *Supra* note 416.
[420] *Supra* note 407 at 4-5.
[421] *Ibid*, at 9.
[422] *Ibid*, at 9.
[423] *Ibid*, at 9-10.

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vehicles.[424] The US, on the other hand, will indemnify claims over the MPL determination, which in some cases could be as low as $3 million.[425] Australia takes the opposite approach and requires that launch participants indemnify the Commonwealth for up to $750 million in respect of all claims against it by any third parties for damage incurred by the space activity.[426]

It is commercial space industry practice that launch participants agree to reciprocal waivers of liability.[427] These waivers of liability are, generally, "an assumption of risk for death, bodily injury, or property damage".[428] Meredith describes that "[t]he purpose of the waivers is: 1) to limit the total amount of claims that would otherwise arise from a launch failure; and 2) to eliminate the need for each launch participant to obtain property and casualty insurance, which would strain the total insurance capacity available for one launch".[429] Industry practice is that the parties to the waiver "flow down" the waiver to any contractors, subcontractors, etc.[430]

In the United States, the Spaceflight operator is required to inform the space flight participant of the risks involved in the space activity. Spaceflight participants ("SFP") are not required to execute cross-waivers of liability with the space operator, but must provide written informed consent to participate in the launch and re-entry,[431] and they must sign a cross-waiver with the federal government, "which means that the party agrees not to seek claims against the federal government if an accident occurs".[432] Informed consent, however, "is predicated on numerous factors including the type of information

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[424] *Ibid*, at 9.
[425] *Supra* note 409.
[426] *Space Activities Act 1998* (Cth), s 49(3).
[427] *Supra* note 416.
[428] *Ibid*, at 1.
[429] *Ibid*, citing US, Senate Committee on Commerce, Science, and Transportation, 100th Cong. *Commercial Space Launch Amendments 1988, Report of the Senate Committee on Commerce, Science, and Transportation on HR 4399* (S Rep No 100-593) (Washington, DC: US Government Printing Office, 1988) at 14.
[430] *Ibid*, at 2.
[431] 51 USC §50905(b)(5)(C).
[432] *Supra* note 407 at 20.

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provided; adequacy of information; and, the person's appreciation of that information".[433] It is difficult to say with certainty "that an SFP would know, just by reading an SFP informed consent form, what risk he or she is assuming".[434]

The Spaceflight operator might request that the spaceflight participant execute a waiver of liability, but it is unlikely the informed consent and waiver of liability will be sufficient to indemnify the operator in the event of an accident. In the United States, waivers of liability "must use precise, plain, and unequivocal language and must be unambiguous, specific, conspicuous, and explicit". [435] The federal government specifically omitted space flight passengers from the requirement to enter into a cross-waiver of liability, saying that "space flight participants wishing to ride on board a launch vehicle have chosen to undertake a risky venture of their own accord. As such, they do not merit the financial security provided by the promise of indemnification". [436] Therefore, it is unlikely that such waivers initiated by spaceflight operators will be enforceable in the US in the event of an accident involving bodily injury or death, "given the lack of federal statutory support".[437]

Thus, while the government indemnification scheme will not apply to third party participants (including subcontractors and space tourists), this does not preclude the need for the insurance market to provide coverage for these entities. Analysis conducted for the purpose of informing the US House of Representatives on this issue revealed that

> [a]n insurance company and a legal expert stated that, without a limitation on liability, insurance premiums for third party and other launch insurance coverage could increase as the same number of insurance companies insures, passengers, crew, launch vehicles, as well as third parties to a launch. According to the FAA, putting a limitation on spaceflight passenger liability could

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[433] Melanie Walker, "Suborbital Space Tourism Flights: An Overview of Some Regulatory Issues at the Interface of Air and Space Law" (2007) 33 J Space L 375 at 382.
[434] *Ibid.*
[435] *Supra* note 416 [footnotes omitted].
[436] US, Bill HR 3752, *Commercial Space Law Amendments Act of 2004*, 108th Cong, 2004 (enacted) as cited in *Supra* note 433 at 386.
[437] *Supra* note 416.

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> foster the development of the commercial space launch industry through lower costs for insurance and liability exposure…Launch and insurance companies believe that a limit or cap on passenger liability could decrease uncertainty and consequently decrease the price of insurance, according to a FAA task force report.[438]

It should be noted that the US government is considering ending the indemnification scheme. Launch providers believe that ending indemnification would raise prices and make companies, and the US less competitive.[439] This is due, in part to the private market capacity for insurance cover, which is generally about $500 million per launch,[440] worldwide.[441] Third party liability coverage for commercial space transportation providers is a "specialized market involving a relatively small number of insurers that each assumes a portion of the risk for each launch".[442] The cost of third party liability insurance for commercial space operators is "approximately 1 percent or less of the total coverage amount".[443] Launch company officials have noted "that the lack of government indemnification would decrease their global competitiveness by increasing launch costs [which] would increase as a result of their likely purchase of greater levels of insurance to protect against increased potential for third party losses".[444] Further, scholars have noted that "the commercial space industry may be indirectly hampered by parameters outlined by insurance companies and by the inability to acquire insurance".[445]

This increase in insurance coverage "might encourage insurers and capital to enter the space launch market and cause liability insurance capacity to increase".[446] This, in turn, could increase the private market capacity for coverage and reduce the challenges

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[438] *Supra* note 407 at 21 [footnotes omitted].
[439] *Ibid.*
[440] *Ibid,* at 15.
[441] *Ibid*, at 16.
[442] *Ibid*, at 15.
[443] *Ibid*, at 15.
[444] *Ibid*, at 24.
[445] Charles W. Stotler, "International and U.S. National Laws Affecting Commercial Space Tourism: How ITAR Tips the Balance Struck Between International Law and the CLSAA" (2007) 33 J Space L 245 at 262.
[446] *Supra* note 407 at 16.

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involved in accumulating the funds to insure such services. Further, an increase in space tourism activities increases the amount of launches, which accordingly increases the risk of failure. This increased volume of launches and re-entries "could increase the overall amount of insurance coverage needed by launch companies, which could raise insurance costs, including those for third party liability".[447] Some launch operators have indicated an intention to "pass additional costs on to their consumers by increasing launch prices".[448] The passing of costs to consumers also has the reverse benefit of passing savings onto consumers. As noted, increased insurance requirements may, at first, raise the cost of space travel. However, in the long run, increased market capacity for insurers means that there may be an opportunity to lower the cost passed on to the consumer, as it would no longer be so difficult for a small number of insurers to find the resources to insure space travel services. Additionally, the establishment of a "cap" on liability would serve to bring clarity to the insurance market, which would bring capacity to the insurance market.

Unification

With the legal uncertainty that applies to the commercial space transportation industry, it is important to recognize the opportunity to move forward on a unified basis in order to establish new space laws for the benefit of mankind as they explore and use space in a new way. A new international legal regime should be established to adequately govern the commercial uses of space. A new model could be in the form of a Protocol to the *Outer Space Treaty*, a Declaration of Principles, or a new Multilateral Treaty. Whatever the instrument, it must contain sufficient certainty to fill the black holes in the current international space law regime. It must be unified in order to prevent fragmentation in its application between States. The international community must come together to determine the way forward.

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[447] *Ibid,* at 20.
[448] *Ibid,* at 24.

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Space laws need to be developed in order to determine where air space ends and outer space begins, in order to determine which legal regime will apply. The specific theory used to differentiate is of no consequence,[449] what matters is that there is clarity of where and when each set of laws apply. The humanitarian objectives of the *Rescue Agreement* should be extended to ensure that space tourists would be rescued in the event of accident, distress, or emergency landing. Further, the registration of space vehicles and space objects needs to be clarified in order to adequately account for commercial space activities and determine the appropriate regulatory authority. Further, international registration needs to be clarified in order to keep States informed of space activities, which could impact upon air or space traffic management. The issue of exploitation of resources by commercial entities needs to be examined and clarified in order to prevent claims of ownership over the common heritage of mankind, which may not be appropriate in the circumstances. To this end, the issue of private ownership in space must also be addressed. Finally, liability needs to be addressed in a comprehensive and dedicated manner.

Liability should be addressed now, and a regime should be established to limit liability. In this liability regime, the State should no longer be ultimately responsible for the activities of its nationals, which will recognize the shift from public to private uses of outer space. Instead, a strict liability regime would be appropriate, whereby an operator would be presumed to be liable and could exonerate itself by proving that it diligently took all steps to avoid a loss, or that any damage incurred was caused by or contributed to by the space tourist. This regime of strict liability should also contain a "*force majeure*" exoneration clause due to the volatility of the space environment. It has been suggested that passenger safety should be considered as the paramount regulatory issue that the industry must address.[450] "A commercial entity that carries passengers must demonstrate some threshold level of assurance that the people who pay for the trip have a reasonable

[449] In this author's opinion. What matters is that there is certainty as to which legal regime applies when.
[450] *Supra* note 244 at 6.

chance of completing it safely".[451] States should develop a mechanism for determining maximum probable loss. Strict guidance on calculations should be provided by governments and used to help space operators to develop their capabilities while maintaining economic resources. This would open the door for more development, as more capital is available that is no longer being spent on unlimited insurance policies.

In exchange for strict liability, the amount claimable should be limited to an appropriate amount. That amount could be determined with respect to a maximum probable loss analysis, such as that undertaken in the United States,[452] and could take into consideration any government claims of indemnity. Again, the exact amount is of no consequence. What matters is that there is clarity and certainty as to what will happen in the event of an unfortunate (but inevitable) catastrophic accident.

The following liability issues should be addressed in an international, unified fashion in order to promote and foster commercial space activities while protecting the interests of all States, and the interests of all mankind:

- Insulation of the launching State for damage caused by private entities' space objects launched from its territory or facility;
- A clear definition of "procuring a launch" and parameters as to when and to what extent that should result in absolute liability for the procurer;
- Explanation of the distinction between "International Responsibility" and "International Liability";
- Applicable limitations on liability;
- Clear and unambiguous definitions of relevant terms, such as:
    - Space Objects, Space Activities, Bodily, Personal, Immaterial, Mental Injury, Loss of Society, Pre-death Suffering, Proximate Cause, Adequate Compensation, Fault, Negligence, Gross Negligence, Wilful Misconduct, Reckless Conduct, Risk Liability, Strict Liability, Absolute Liability;
- Recognition of causes of action and the defences thereto;
- Parameters for determining which damages are claimable, recoverable, and compensable;

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[451] *Ibid.*
[452] Subject to the caveats regarding updating the MPL methodology noted above.

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- Consideration of how *restitutio in integrum* can be achieved;
- Clear determination of which law applies where and under what circumstances;
- Consideration of jurisdiction and standing to bring or adjudicate a claim;
- Exonerating circumstances, such as "due care" or contributory negligence;
- Limitation periods;
- Requirement to hold liability and/or accident insurance;
- Consideration of third party product liability and/or manufacturers liability;
- Recognition of public interest in space activities;
- Acts of God or "*Force majeure*";
- Procedures for arbitration and/or dispute resolution. [453]

These questions should be carefully considered and analysed when considering the way forward for international regulation of commercial space transportation. A model regime would be practical and leave room for interpretation and growth.[454]As we are at the beginning stages of this industry, a regime that does not leave room for interpretation would have to be constantly revised as times change. Freeland notes that "As technology is developed to make widespread tourism a reality, it is incumbent on the law itself to develop in order to meet the demands for proper regulation of such activities".[455]

States could come together to develop and enact a new Multilateral agreement, the first new 'hard law' space Treaty since the *Moon Agreement*. UNOOSA could be designated as the regulatory body. In order to promote efficiency and expediency, UNOOSA could use ICAO's secretariat for resources, and draw upon air law and other similar international legal regimes, such as the laws that govern the seas and Antarctica. UNOOSA could report directly to the UN General Assembly, and the Legal

[453] Henri A. Wassenbergh, "The Law of Commercial Space Activities" in Gabriel Lafferranderie and Daphné Crowther, eds, *Outlook On Space Law Over the Next 30 Years*, (The Hague, Netherlands: 1997)173 at 180-181.
[454] Rebekah Davis Reed, "Ad Astra Per Aspera: Shaping a Liability Regime for the Future of Space Tourism" (2009-2010) 46 Hous L Rev 585.
[455] *Supra* note 7 at 4.

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Subcommittee could work with the Legal and External Relations Bureau at ICAO to streamline processes and collaborate to improve air and space safety.

The reality of the length of time it takes to draft, achieve consensus, and implement, a multilateral treaty may take more time then the industry has to wait before new regulations are put in place. Freeland notes that,

> [a] comprehensive and uniform legal regime that specifically envisages and applies to the complete launch and return journey of private individuals should be preferred. However, given the long lead time that would be required to negotiate and agree to a new multilateral treaty, this is perhaps not a very realistic response for the short term and will not solve the immediate problems of today's space tourism entrepreneurs.[456]

Thus, another option is a Protocol to the *Outer Space Treaty*. Such a protocol should include:

> 1) the fundamental legal principles (particularly those that establish the global public interest) that have already been adopted;
> 2) clear rules of law that would govern all space activities, including those undertaken by private entities and covering issues related to space debris, intellectual property rights, etc;
> 3) un-ambiguous definitions of the terms used;
> 4) an efficient dispute settlement mechanism; and
> 5) sufficient provisions for the protocol's amendment.[457]

Another option is to adopt an international declaration of basic, broad, an high-level voluntary principles.[458] Principles from universally acknowledged foundational beliefs of other international industries can be used to form the foundation of such a declaration.[459] The principles should relate to "universal access" and the "highest degree

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[456] *Ibid* at 13.
[457] *Supra* note 10 at 107.
[458] Ram Jakhu, "Access to and Equity in Aerospace Transportation" (Presentation delivered at the ICAO/UNOOSA Aerospace Symposium, ICAO Headquarters, Montréal, Canada, 18-20 March 2015, online: ICAO.int <http://www.icao.int/Meetings/SPACE2015/Presentations/5%20-%20R.%20Jakhu%20-%20McGill%20University.pdf>.
[459] *Ibid.*

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of safety and security".[460] There should be "uniformity of standards" and "international cooperation" to allow "opportunity for participation".[461] There should be a "single international organization" responsible for overseeing commercial space activities, and consideration should also be given to "other matters" that may be or become relevant.[462]

Eminent scholar Dr. Ram Jakhu prepared a recommendation of what the declaration could look like for the consideration of the ICAO/UNOOSA Aerospace Symposium, which included participants from over thirty States.[463] The recommendation includes five Principles:

> Principle I:
> States should co-operate so as to promote the availability of aerospace transportation services to all countries and people of the world as soon as is feasible and practicable on a global and non-discriminatory basis.
>
> Principle II:
> Global aerospace transportation services should be established on the basis of highest possible degree of safety, efficiency, reliability and security, and take into careful consideration the safety of existing aviation transportation and other uses of air space and outer space.
>
> Principle III:
> In order to secure the highest practicable degree of uniformity in standards and procedures, all international standards and recommended practices and procedures relating to global aerospace transportation services should be adopted by the International Civil Aviation Organisation, after active consultation with all stakeholders.
>
> Principle IV:
> Free and fair world-wide competition, in accordance with fundamental principles governing international trade and commerce, should be fostered in relation to all aspects of global aerospace transportation services.

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[460] *Ibid.*
[461] *Ibid.*
[462] *Ibid.*
[463] ICAO, "ICAO Space 2015 – List of Participants" (23 April 2015) online: ICAO.int <http://www.icao.int/Meetings/SPACE2015/Documents/SPACE%202015_LIST%20OF%20PARTICIPANTS_FINAL2.pdf>.

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> Principle V:
> All interested intergovernmental and non-governmental organizations, national policy makers, regulatory authorities, aerospace operators, service providers and manufacturer should make every possible effort to follow these voluntary principles with a view to facilitating coordinated solutions and the full implementation of a safe and efficient global aerospace transportation industry as soon as possible.[464]

It is recommended that this proposal be used as a starting point for unification. The principles should form the foundation upon which a new liability regime is established. The new liability regime should specifically include a limitation or 'cap' on liability in order to provide greater certainty to space insurers, commercial space transportation operators and regulators. The establishment of a cap on liability would have the effect of allowing financiers and operators to know their liability in the event of an accident. While the establishment of such a system may be time and resource consuming at the outset, in the long run, this is the best way to move forward.

The development of new international laws would prepare the international community to accept and support the commercial space transportation industry. A comprehensive liability regime will benefit the community by giving States clarity of law. A comprehensive liability regime will also help operators to insure their services by allowing them to determine a maximum probable loss, which may have the effect of lowering insurance costs and, accordingly, operational costs. These lower costs can then be passed on to the consumer, or space flight participant, who will be more inclined to participate in commercial space transportation when it comes with a lower price tag.

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[464] *Supra* note 458.

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Chapter Six: Lift-off

What is the most appropriate way to govern commercial space transportation? There is no conclusive answer, but States and scholars have started thinking about the issue and there are some identified areas where current international space law is lacking, as described above. Those areas must be included in the analysis and any proposals for unification going forward. Specifically, in relation to liability, how can we protect space passengers while promoting and fostering the growth of the industry? The growth of the aviation industry, and the liability issues that have arisen demonstrate why it is important to implement forward thinking regulations in the near future instead of taking a "wait and see" approach. The last thirty years since the conclusion of the *Moon Agreement* was spent waiting and seeing. The time for action and unification is now.

The early stages of commercial space transportation bear similar resemblance to the development of the aviation industry. International aviation law was developed when aviation was at its infancy. "Space travel stands at exactly the same crossroad as air transportation did in the early 1920's".[465] In 1929, the *Warsaw Convention* was signed, which introduced a liability scheme for aviation. It is thought that the implementation of such a scheme assisted the development of the aviation industry, as it allowed air operators to have some certainty with respect to the approximate liability exposure in the event of an accident. Safety issues in commercial space transportation will by land large be similar to those encountered in other forms of transportation.[466] Furthermore, it has been noted that "notwithstanding the fact that the space tourism industry is in a nascent state it will still be expected to adopt today's approach to safety as in aviation and other industries".[467] As such, it is suggested that a comprehensive liability regime should pre-empt the sophisticated development of the space transportation industry. While there have been a number of overly ambitious forecasts for when this project will get off the

[465] *Supra* note 406 at 962.
[466] *Supra* note 87 at 258.
[467] *Ibid,* at 258.

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ground, the infrastructure and demand is sufficiently in place to create a real and pressing need to address the legal issues of these human space flight corporations. When Sir Richard Branson is asked why the Virgin Galactic launch forecasts have been pushed back from 2007 to date, Sir Richard aptly responds "it is rocket science!".[468] It will take some time for consensus to be reached and any proposal integrated into national laws. Thus, the discussion must be continued and pursued post-haste in order to avoid falling behind the curve and attempting to play catch-up after the industry has evolved.

The fundamental differences between air transport and space transport "justifies the necessity of developing a distinct legal regime for space travel".[469] A proposal that integrates lessons learnt from international and national regulation, attempts to determine which regulations are the most practical, and leaves significant room for interpretation and growth will benefit the international space community as new forms of space travel are contemplated and developed. A practical model will be based on what is known about the commercial space transportation industry today, and what has been learnt from the development of other industries. A model that leaves room for interpretation is necessary, because this area is evolving and it would not be appropriate to develop a liability regime that would only apply to the industry as we see it today. That is, after all, one of the fatal flaws of the current state of space law: it does not consider the future in a practical way.

A reassessment of space law is required at this juncture as a new industry blasts off. The current space law has many "black holes" of liability, including provisions relating to the status of "astronauts" vis-à-vis "space tourists", State liability for space tourism, standing to bring a claim, informed consent and insurance, to name a few. One of the most important Treaties of space law that must be revisited at this juncture is the *Liability Convention*. Considering the development of the aviation industry, the opportunity arises to learn from past successes and pitfalls. Therefore, it is proposed that

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[468] David Crow, "Better Late Than Never for Sir Richard Branson's Virgin Galactic" (26 September 2014) online: Financial Times <http://www.ft.com/cms/s/0/8a4d336e-432b-11e4-9a58-00144feabdc0.html#axzz3iQ1NfHhz> [emphasis added].
[469] *Supra* note 406 at 963.

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a multilateral legal regime be instituted in order to place a "cap" on liability. Such a limitation on liability would provide benefits for space travel much like it did air transport. By providing financial certainty to investors and insurers by defining a maximum probable loss, the result will be lower prices and increased accessibility for consumers, which will allow the space travel industry to blast off into profitability. New forms of commercial uses of outer space will emerge in new and exciting fashions in the coming years. It is suggested that only with legal certainty will this industry reach its full potential.

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