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Masson-Zwaan, T.L.; Freeland, S.

Acta Astronautica 66 (2010) 1597–1607

Contents lists available at ScienceDirect

Acta Astronautica

journal homepage: www.elsevier.com/locate/actaastro

Between heaven and earth: The legal challenges of human space travel ☆

Tanja Masson-Zwaan [a,*,1], Steven Freeland [b,2]

[a] International Institute of Air and Space Law, Leiden University, the Netherlands
[b] School of Law, University of Western Sydney, Australia

ARTICLE INFO

Article history:
Received 13 June 2009
Received in revised form
7 December 2009
Accepted 18 December 2009
Available online 1 February 2010

Keywords:
Space law
Space tourism
Private human access to space

ABSTRACT

Since the first space object was launched into orbit in 1957, humankind has been engaged in a constant effort to realise ever more ambitious plans for space travel. Probably the single most important element in this ongoing evolution is the development of technology capable of transporting large numbers of passengers into outer space on a commercial basis. Within the foreseeable future, space will no longer be the sole domain of professionally trained astronauts or the exceptionally wealthy.

The prospects for both suborbital and orbital private human access to space give rise to some interesting and difficult legal questions. It also opens up an exciting opportunity to develop an adequate system of legal regulation to deal with these activities. The 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. The lack of legal clarity represents a major challenge and must be addressed as soon as possible, to provide for appropriate standards and further encourage (not discourage) such activities.

This article will examine some of the more pressing legal issues associated with the regulation of space transportation of passengers on a commercial basis, seen in the light of Article 1 of the Outer Space Treaty of 1967, which states that the 'exploration and use of outer space [...] shall be carried out for the benefit and in the interests of all countries [...] and shall be the province of all mankind'. An appropriate balance must be found between the commercial and technological opportunities that will arise and the principles upon which the development of international space law have thus far been based.

1. Introduction

Although the range of activities undertaken in outer space has grown exponentially since the launch of Sputnik in 1957, we are only now on the threshold of the next great 'leap' to space. The realisation of affordable and safe commercial private human access to outer space may be as significant to mankind as the Wright brothers' Flyer, Gagarin's first spaceflight and the Saturn V 'Moon rocket' that put Aldrin and Armstrong on the Moon. The successful 'launch' of SpaceShipOne from its mother plane

☆ This article is an elaboration of the paper presented by the authors at the 1st IAA Symposium on Private Manned Access to Space held on May 28–30, 2008 in Arcachon, France. All websites quoted in this article have been accessed in June 2009. Copyright© 2009 by the authors.

* Corresponding author.
E-mail addresses: t.l.masson@law.leidenuniv.nl (T. Masson-Zwaan), s.freeland@uws.edu.au (S. Freeland).
[1] President, International Institute of Space Law (IISL), the Netherlands.
[2] Visiting Professor of International Law, University of Copenhagen, Denmark.

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doi:10.1016/j.actaastro.2009.12.015

White Knight in October 2004, followed by its second return journey in 7 days to an altitude of over 100 km, demonstrated that the technology for short-term human suborbital flight has arrived. This remarkable event immediately seized the imagination of the public. Other companies started similar ventures; a new industry was born. Thanks to SpaceShipOne and the Ansari Xprize, space has gained renewed attention of the world. Perhaps this is the new boost we were all waiting for![3]

Virgin Galactic is proceeding with plans to provide passengers with the opportunity of a 21/2 h journey into space, for US$200,000 a seat, and hundreds of people have reportedly already signed up.[4] Other even more ambitious proposals, involving orbital travel, hotels and various space adventures, have captured widespread imagination as entrepreneurs, scientists and industrialists conceive of further value-added products designed to enhance the overall space tourism experience.[5]

Without a doubt the prospect of commercial 'space tourism', not only suborbital but also orbital, has begun to generate widespread interest and excitement. It has also encouraged many millions of dollars of investment. Its development represents a quantum leap from the 'early' days of private human access to space, which has largely been restricted to a few very wealthy individuals.[6]

2. The limitations of existing international space law

Before discussing the requirements for an adequate legal framework to regulate orbital or suborbital private human spaceflight, a few remarks can be made about the existing *corpus iuris spatialis*. The five multilateral space treaties elaborated within the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) were largely formulated in the 'Cold War' era, when only a small number of countries had space-faring capability.[7] Although the treaties are to be admired for their simple yet comprehensive coverage of potential human involvement in the realm of outer space, the treaties could not fully anticipate the extent to which humankind would one day engage in commercial space tourism activities. The Outer Space Treaty, for instance, did foresee that private entities would one day engage in space activities,[8] yet one of the most essential topics for private operators, namely their exposure to second- or third-party liability,[9] is not addressed. Instead, the Treaty, as well as the Liability Convention, only addresses liability at the level of the States involved. There is no cap on liability of operators, and no opportunity for passengers or third parties to present direct claims for compensation.[10]

Thus, even though the treaties maintain their relevance even after several decades, the existing international legal regime is not able to accommodate the remarkable technological and commercial progress associated with space activities. It needs to be supplemented with additional and more specific rules, in order to complement the general rules laid down in those early instruments. This represents a major challenge, all the more in view of the strategic, military and commercial importance of outer space, which always has been and will continue to be extremely influential.

3. What is space tourism?

The term 'space tourism' has been defined as 'any commercial activity offering customers direct or indirect

[3] After the early days of excitement, space became just another everyday feat. The incredible achievement of a permanently inhabited station in space, including the launches of ESA's Columbus lab and ATV Jules Verne and the Japanese lab Kibo in 2008, did not by far have the same impact as, for instance, the landing on the Moon in 1969, when everyone was glued to their television to witness this 'giant leap for mankind'.

[4] See http://www.virgingalactic.com. Virgin Galactic is generally expected to be the first operational provider of suborbital flights. Up to 300 Virgin Galactic 'astronauts' could venture to space in the foreseeable future. Stephen Hawking is among them. Tickets cost $200,000 and deposits start from $20,000. US export control requirements may cause delays, see for instance Irene Mona, *Red Tape for SpaceShipTwo* at http://www.spacedaily.com/news/spacetravel-05y.html. SpaceShipTwo was unveiled in January 2008. See http://www.newscientist.com/article/dn13219. See for market surveys the Futron report of 2002 and its update of 2006, http://www.futron.com/pdf/resource_center/white_papers/STMS_Suborbital.pdf and http://www.futron.com/pdf/resource_center/white_papers/SpaceTourismRevisited.pdf/.

[5] See for an overview, Jacqui Goddard, *Up, up and Ka-Ching!*, in Newsweek, February 2, 2008, available at: http://www.newsweek.com/id/107550. See also http://www.personalspaceflight.info/.

[6] In April 2001, the first ever space tourist Dennis Tito spent 6 days in the Russian section of the ISS, after extensive training at the Star City complex. After him, five others have followed; Mark Shuttleworth in 2002, Gregory Olsen in 2005, Anousheh Ansari in 2006, Charles Simonyi in April 2007 (and again in 2009) and Richard Garriott in October 2008. The price for a flight brokered by Space Adventures to the ISS on board Soyuz is now around $35 million. Recent reports claimed that space tourism seats will be unavailable on Soyuz spacecraft for the next few years, since the International Space Station doubled its crew size up to six people in May 2009. However it is now reported that Cirque du Soleil founder Guy Laliberté may fly to the ISS in September 2009, as Kazakhstan cancelled its plans to send a trained cosmonaut, see http://www.space.com/missionlaunches/090403-space-adventures-future.html. After that, according to the Russians, this form of space tourism will also continue. See http://uk.reuters.com/article/scienceNewsMolt/idUKTRE54C48520090513.

[7] (i) Treaty on principles governing the activities of States in the exploration and use of outer space, including the moon and other celestial bodies 18 UST 2410 (1967) (Outer Space Treaty); (ii) agreement on the rescue of astronauts, the return of astronauts and the return of objects launched into outer space (Rescue Agreement); (iii) convention on international liability for damage caused by space objects 672 United Nations Treaty Series 119 (1968) 24 UST 2389 (1972) (Liability Convention); (iv) convention on registration of objects launched into outer space 28 UST 695 (1975) (Registration Agreement); and (v) agreement governing the activities of States on the moon and other celestial bodies 1363 United Nations Treaty Series 3 (1979) (Moon Agreement). Texts of all of these treaties can be found at http://www.unoosa.org/oosa/en/SpaceLaw/treaties.html.

[8] Cf. Article VI Outer Space Treaty, which makes a State internationally responsible for activities carried out by non-governmental entities, provided that it authorises and supervises such activities.

[9] Second-party or contractual liability refers to liability of the operator vis-à-vis passengers and cargo, while third-party or non-contractual (tort) liability refers to liability for damage to persons or property on the ground, who have no contractual relations with the activities of the operators, they were just in the wrong place at the wrong time.

[10] Liability is addressed in more detail below.

experience with space travel'[11] and a space tourist as 'someone who tours or travels into, to, or through space or to a celestial body for pleasure and/or recreation'[12].

But it is important to place this phenomenon into its proper context. Since the sixties, approximately 500 persons have gone into outer space; they were without any doubt 'Envoys of Mankind'.[13] A mere six of these were tourists.[14] As at 2008, NASA, with the largest astronaut corps worldwide, had 88 active astronauts.[15] ESA had eight. With the advent of larger scale commercial space tourism, these numbers will increase dramatically. However it is not expected that thousands of tourists will be lining up at ticket counters to go into outer space.[16] It will not involve hordes of tourists and any comparison with, for instance, a beach resort in Torremolinos or even a luxury cruise ship on the Nile seems inappropriate. Most concepts developed today concern a maximum of 4–6 seats for 'tourists'. It will remain for a long time a risky and costly trip, for which a good physical condition is essential. Even professional astronauts have suffered numerous medical problems related to their stay in outer space, more or less serious depending on the length and distance of the mission, and much is probably still unknown about long-term effects of space travel.

What is called 'space tourism' is more an opportunity for the happy few who are so eager to go up there that they are willing to accept certain risks. This may change in the future, but the suggestion that thousands of people will gain their 'astronaut wings', which the term 'tourism' seems to imply, is still some way off.

For the present time, therefore, perhaps 'private space travel' is a better term?

Current developments in this area are often explained as being part of a chronological and evolutionary chain, starting with the relatively 'simple' suborbital space tourism ventures (in some cases there is not even a pilot on board and it resembles more a ride on Disney's Spacemountain!) that appear to be technologically feasible today, via long-range intercontinental transport through outer space, to economically feasible fully reusable orbital launch vehicles (RLV) in the future.[17]

3.1. Suborbital spaceflight

Suborbital spaceflight, which is what most current projects will offer, covers flights in which orbital velocities are not achieved. After engine shutdown, 3–6 min of microgravity is achieved, after which the vehicle falls back to Earth and re-enters the atmosphere. They usually attain an altitude of around 100 km, a fact that is also dictated by the relevant scientific principles. Numerous different technologies are under consideration. Some concepts involve a horizontal take-off or 'launch' (sometimes from an aircraft, like WhiteKnight2), while others take off vertically. From ground to space, concepts can be Single Stage, Dual Stage, Multiple Stage, with a carrier, from an aircraft, from a balloon, or using rocket propulsion. One of the technology challenges is to get as many kg's in (sub-)orbit compared to kg's needed for propulsion (and to do that safely). From space to ground, they can vary from aircraft to parachute, and here, one of the technology challenges is thermal protection during re-entry into the atmosphere.[18]

3.2. Orbital spaceflight

The velocity required to stay in an orbit is called 'orbital velocity' and depends on the altitude of the orbit. In orbital spaceflight, orbital velocity must be achieved for the vehicle to keep flying along the curvature of Earth and not fall back to Earth. For a 200 km circular orbit, the orbital velocity is 28,000 km/h, and it is this extremely high speed which makes orbital space flight technically so complex and therefore expensive. Private orbital spaceflight for human clients on a commercial basis is obviously much more demanding in terms of technology and economics (what will tickets cost?) than suborbital flight, but this has not prevented enterprises such as Excalibur Almaz and SpaceX from engaging in this business.

3.3. Intercontinental rocket transport

Intercontinental rocket transport implies a transit through space in order to substantially shorten the travel time from one point on earth to another. It is an idea that has already existed for a long time-remember in the 1980s the US National Aerospace Plane (NASP) or the UK HOTOL (Horizontal Take-off and Landing) projects.[19] This concept might be attractive for the military as well as for commercial transportation of passengers and goods. However, the technical challenges are huge in terms of the required velocity, the amount of propellant required, and the need for a robust thermal protection system (TPS) for safe re-entry. Cost is also a highly relevant

[11] Stephan Hobe and Jürgen Cloppenburg, *Towards a New Aerospace Convention?—Selected Legal Issues of "Space Tourism"*, in: Proceedings of the 47th Colloquium on the Law of Outer Space 377 (2004).

[12] Zeldine O'Brien, *Liability for Injury, Loss or Damage to the Space Tourist*, in: Proceedings of the 47th Colloquium on the Law of Outer Space 386 (2004).

[13] Cf. Article V Outer Space Treaty, and the Rescue Agreement.

[14] But the 'tourists' who went up to the ISS do not like to be called as such. Says Anousheh Ansari: 'I was part of a six-month training program along side the other crew members and I took an active role as a crew member. I think the term 'space tourist' undermines what you have to do on the mission', see http://www.anoushehansari.com/faqs/. Tito and Olsen have expressed similar disapproval of the term.

[15] See Jeff Foust, *So you want to be a Rocket Pilot*, 7 April 2008, available at: http://www.thespacereview.com/article/1099/1.

[16] Although some travel agents are already marketing space trips, http://www.personalspaceflight.info/2007/11/28/whats-in-it-for-space-travel-agents/. See also the Futron reports, *supra* note 2.

[17] See for an explanation of the concepts of suborbital vs. orbital, http://orbspace.com/background-information/suborbital-vs-orbital-space-flight.html.

[18] Cf. Erik Laan. *Technological aspects of Space Tourism*, presentation made at the Leiden LLM programme in air and space law, May 2009.

[19] For an overview of legal issues of aerospace planes, see Tanja L. Masson-Zwaan, *The aerospace plane: an object at the cross-roads between air and space law*, in: Air and Space Law: *de lege ferenda* (Essays in Honour of Henri A. Wassenbergh), (T. Masson-Zwaan/P. Mendes de Leon, eds.), 247–261 (Nijhoff 1992).

consideration–witness the fact that the Concorde flights were always a 'loss maker' for both British Airways and Air France (although, of course, they most likely generated income in other indirect marketing and prestige-related ways).

The bottom line is that a useful suborbital transport would require many of the same design features of an orbital vehicle, and the cost for transporting a passenger or cargo would be similar for the cost of using an RLV. Therefore it has been suggested that the way forward for RLV development would be to skip the prohibitive intercontinental rocket transport concepts, as perhaps the 'development of and operational experience with orbital RLV's needs to pave the way for any future point-to-point rocket transport, rather than the other way round'.[20]

It seems doubtful that tomorrow's suborbital flight will eventually develop into point-to-point transportation, as Virgin Galactic and others seem to envisage. This would impact on the credibility of the planned V-Prize, in which spaceflight companies are to compete 'to become the first in history to create a vehicle capable of launching from Virginia and land in Europe in approximately an hour'. The foundation realises that 'regulatory problems will have to be settled and some international treaties modified' in order to authorise this type of intercontinental flight.[21] It seems highly uncertain that this will happen, at least in the short to medium term.

In view of the current 'remoteness' of this possibility, we do not intend to propose here choices as to the legal regime governing it. Time will tell if it is going to happen, and we can then think about the legal framework. It may well be, for example, that a new branch of international law—'Aerospace Law'—may emerge. It is simply too early at this stage to know.

4. The law

We have observed that many excellent and in-depth academic papers have been written in recent years about the legal aspects of 'private space travel'.[22] We intend to not duplicate these and will provide a summary overview of some of the legal issues involved and make some proposals for solutions.

It is important to remember that the United Nations space law treaties apply to the relations between different States with regard to space activities and space objects, and that international air law conventions such as Chicago, Warsaw or Montreal are concerned with international commercial carriage by air(craft). Many of the currently planned space tourism projects will operate from one and the same territory. As long as the intended vehicles will 'take off' and 'land' in that territory, the likelihood of cross-border damage is limited, and in principle that State's national law will apply, whether it concerns orbital or suborbital flight.

4.1. National legislation applying to non-cross-border space tourism

Several countries have enacted national space legislation, but they have not always addressed 'space tourism'.[23] In view of the limited scope of this article, we will limit ourselves to a brief discussion of the national regulation of private human spaceflight in the USA and in Europe.

4.1.1. USA

Most of the current projects are being undertaken in the USA and will 'take off' and 'land' there. The US Government has passed quite a substantive body of rules governing private human spaceflight, mainly designed to enable entrepreneurs to go ahead with offering suborbital flights under conditions which are less stringent than for classical transport. These rules apply at least until December 2012, but will probably remain applicable longer than that, because commercial space tourism has not commenced as early as was initially expected. The first commercial flights may not happen until 2012, and therefore the expected initial experience will not have been gained by then. The Government provides licences to build a number of spaceports across the country (proposals for spaceports have been mooted for California, Oklahoma, New Mexico, Virginia, Wisconsin, Alaska and Florida), alleviates the rules for selling flights to humans and determines the rights and obligations of the operator, the crew and the space flight participant. A company proposing to launch paying passengers from US territory on a suborbital rocket must receive a licence from the FAA's Office of Commercial Space Transportation (FAA/AST). The licensing process mostly focuses on public safety and safety of property.[24] What is striking is the way

[20] See David Hoerr, *Point-to-point Suborbital Transportation: Sounds Good on Paper, But…*, May 5, 2008, available at: http://www.thespacereview.com/article/1118/1.

[21] See for details Paul de Brem, *the V-Prize*: *one hour to Europe*, August 27, 2007, available at: http://www.thespacereview.com/article/940/1. The venture must be completed by July 1, 2013, when the 'Spaceflight Liability and Immunity Act' passed by the state of Virginia to encourage the development of research on manned flights expires. According to this Act, a company organizing a space voyage cannot be held liable for personal injury to passengers who have signed a disclaimer. Note that the V-prize website is no longer online, which may cast doubt on its viability.

[22] See for instance Stephan Hobe, Gerardine Goh and Julia Neumann, *Space Tourism Activities—Emerging Challenges to Air and Space Law*?, in: 33 Journal of Space Law 359 (2007), Frans von der Dunk, *Passing the Buck to Rogers*: *International Liability Issues in Private Spaceflight,* in 86 Nebraska Law Review 400 (2007), Stephan Hobe, *Legal Aspects of Space Tourism, ibid*. at 439 and Steven Freeland, *Up, up and… Back: The Emergence of Space Tourism and its Impact on the International Law of Outer Space*, in 6 Chicago Journal of International Law 1 (2005). These recent articles contain extensive references to the majority of earlier publications in this field.

[23] An overview and texts are available at: http://www.unoosa.org/oosa/en/SpaceLaw/national/index.html.

[24] Code of Federal Regulations (CFR), Title 14, Chapter III. This is in accordance with the commercial space launch amendments act (CSLAA) of 2004. See especially human space flight requirements (HSFR), 14 CFR §460, which provides the rules for launch and reentry with crew, and with space flight participants. The relevant parts are 14 CFR 401, 415, 431, 435, 440 and 460, accessible at http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?sid=6a5153b45a2675c8b05adfd8d7195483&c=ecfr&tpl=/ecfrbrowse/Title14/14cfrv4_02.tpl#300. See also Melanie Walker, *Suborbital*

that many of the providers have more stringent requirements than is stipulated under existing law.

4.1.2. Europe

Europe lags behind. This is a problem, considering that, for instance, Virgin Galactic has concluded an agreement with the Swedish Space Corporation (SSC) to launch from Kiruna, Sweden in the future.[25] Also, there are plans for a spaceport in the Netherlands' Antilles, (Spaceport Caribbean), while the Netherlands has recently enacted its national space legislation.[26] Similarly in France, with plans for a spaceport in Montpellier (Spaceport France) and a national law is being finalised.[27] And there are others. Even though missions taking off from a European spaceport may not be intended to cross borders, the relatively small size of European states (as compared to the Mojave desert in the USA for instance!) may well imply that the chances of causing damage across borders increases. Now that several countries in Europe have started to enact national space legislation, even though for the time being they do not concern 'space tourism'[28], harmonisation is becoming urgent. These national laws show a patchwork of differing rules and regulations, and the lack of harmonisation may result in a situation that will not be beneficial for the industry. It may also lead to the undesirable practices of 'flags of convenience' or 'forum shopping'.

4.1.3. Attempts at harmonisation in Europe

Recently in Europe, not only ESA is active in space but the European Union (EU) has taken a role in projects such as Galileo and GMES, and the two organisations concluded a Framework Agreement which entered into force in May 2004. This agreement establishes regular meetings of the EU and the ESA at ministerial level within a 'Space Council', for coordinating and facilitating cooperative activities. In this context, in May 2007 the Commission and the Director General of ESA jointly presented the European Space Policy, which was endorsed by the Space Council and formally adopted by both organisations.[29] The Policy does not refer to space tourism.

ESA issued a press release in May 2008 about its position with regard to space tourism, after having published a position paper on privately-funded suborbital spaceflight in April 2008[30] The press release states that ESA recognises the private sector's efforts in the achievement of suborbital flights and in the associated technological development, and it intends to help provide the necessary environment for this industry to flourish, for instance, 'by assisting in the setting up of legal frameworks for operation across Europe, involving civil aviation authorities and other relevant bodies in a debate on this matter.' It also states that 'ESA must be careful not to interfere in a fully competitive market'; thus it is not to be expected that ESA will play a pioneering role–this being quite similar in approach to NASA in the USA.

The position paper provides the ESA definition of space tourism: 'the execution of suborbital flights by privately-funded and/or privately operated vehicles and the associated technology development driven by the space tourism market'. It observes that, since space tourism will be substantially carried out in airspace, the civil aviation authorities concerned and the competent agencies of the EU (i.e. the European Aviation Safety Agency, EASA, see below) should be at the forefront of setting up of a regulatory framework for space tourism in Europe. It then observes that 'since in the longer term space tourism will involve travelling to outer space, some rules of space law may find application for space tourism'. This seems to imply that ESA sees suborbital flights as an *aviation* activity to which *air* law must be applied (applying a 'spatialist' rather than a 'functionalist' approach), and would only look at space law for orbital space tourism. The EU has so far not expressed its views on the issue.

We agree that it would be desirable that the EU addresses the issue of regulating private human spaceflight at the European level, possibly giving a role to EASA,[31] Europe's counterpart to the US FAA, with regard to safety and licensing issues of 'space tourism'. Indeed, after ESA's position-taking as described above, Marciacq et. al. of EASA have suggested a regulatory approach for suborbital space tourism at the 3rd IAASS Conference held

(*footnote continued*)
space tourism flights: an overview of some regulatory issues at the interface of air and space law, in 33 Journal of Space Law 375 (2007).

[25] Peter de Selding and Tarek Maliq, Virgin, Swedish Spaceport Sign Deal for Suborbital Flights, Space News, February 5, 2007, available at: http://www.space.com/spacenews/archive07/virginsweden_0205.html. See also http://www.ssc.se/?id=9500. Sweden has a national space law but may soon remodel it after the US legislation. It may treat SpaceShipTwo as a sounding rocket, which under the current act is not regarded as a space activity. See for the text the website mentioned *supra* note 21. See also von der Dunk's discussion in his article quoted *supra* note 20 at 419. See also Blount, *Jurisdiction in Outer Space, Challenges of Private Individuals in Space*, 33 Journal of Space Law 299 at 329 (2007).

[26] See http://www.spacehorizon.com/spaceportpartners.html. The project intends to use the existing airport for suborbital air-launched spaceflights. See for the Dutch Space Act, the website mentioned *supra* note 21

[27] See http://spatioportfrance.free.fr/. However, the project is reported to be on hold. For the French 'Loi no. 2008-518 du 3 juin 2008 relative aux opérations spatiales', JO (Official Journal) 129, 4 June 2008, see http://www.senat.fr/dossierleg/pjl06-297.html. The implementing decree is still pending and full implementation is expected in mid-2010. Another European spaceport is being planned in Scotland, see http://www.spaceportscotland.org/, while the UK is also reforming its Outer Space Act of 1986.

[28] However, the Dutch law for instance contains a provision stating that it can also be declared 'wholly or partly applicable to the organization of outer space activities by a natural or juridical person from within the Netherlands' (Section 2.2.b). The explanatory note states: 'This might include the commercial organization of space tourism activities'.

[29] See regarding the Framework Agreement, http://eu.spaceref.com/news/viewpr.html?pid=13111 and for its text, http://ec.europa.eu/enterprise/newsroom/cf/document.cfm?action=display&doc_id=2322&userservice_id=1. See for the Resolution on the European Space Policy, ESA BR 269 22.05.07, http://esamultimedia.esa.int/docs/BR/ESA_BR_269_22-05-07.pdf.

[30] See the press release at http://www.esa.int/esaCP/SEM49X0YUF-F_index_0.html, and the position paper at http://esamultimedia.esa.int/docs/gsp/Suborbital_Spaceflight_ESA_Position_Paper_14April08.pdf.

[31] EASA is an Agency of the EU charged with aviation safety. Its mission is to promote the highest common standards of safety and environmental protection in civil aviation. See http://www.easa.eu.int.

in Rome in October 2008.[32] In their conference paper, the authors argue that EASA adopt the ESA definition quoted above, but, regarding its involvement, limit it to what they term 'winged aircraft', including rocket-powered airplanes, calling them 'Sub-orbital Aeroplanes' (SoA's). This excludes rockets, and thus space tourism ventures using the concept of a vertical take-off. The authors hold that EASA has regulatory competence over SoA's, which could be treated as an aircraft in a similar way to what EASA has done with Unmanned Aerial Systems (UAS), complementing existing rules to capture their specific features. The paper provides a detailed description of EASA procedures in the field of airworthiness (type certificates), air operations and flight crew licensing and how they could be applied to space tourism within the narrow definition of winged vehicles. One of the reasons why the authors suggest that EASA should adopt a more restrictive approach to space tourism than the FAA is that it issues certificates, whereas the FAA issues licences. Certification entails responsibility of the agency, while licensing leaves the responsibility with the operator.[33]

Marciacq et al. claim that EASA has no competence for 'that (very short) outer space part of sub-orbital flight, unless it agrees with the States to enforce this responsibility on their behalf'. The paper makes a surprising observation about the phase of the flight that takes place in outer space, by saying that even though, for that part, space law would apply and the object would qualify as a 'space object', it would not need to fulfill the requirement of registration under the space treaties, because registration is only necessary for objects launched into an earth orbit or beyond.[34] The paper recognises that this might imply that no State has jurisdiction over the object while in space (since the state of registry has jurisdiction and control), but resolves this by observing that, under Article VI of the Outer Space Treaty, the State would still have control over the object. We do not believe this is a correct interpretation of the space treaties and would prefer to apply one single regime to the entire sub-orbital space tourism flight, i.e. space law (cf. *infra*), rather than having different regimes apply to different phases of the mission, and in addition to that, different regimes according to whether it concerns a horizontal take-off concept or one using a vertical rocket launch but otherwise presenting similar mission characteristics. This approach would not benefit the legal certainty and uniformity that are required to sustain the nascent space tourism industry.

It must be noted that EASA does have the possibility to exclude certain aircraft from its regulation, under Annex II to the 'Basic Regulation' establishing EASA.[35] This exclusion applies for instance to historic aircraft, research, experimental or scientific aircraft, military or police aircraft; however EASA has apparently chosen not to use Annex II for SoA's and prefers to require full certification for commercial space tourism flights. This may have significant consequences for the space tourism industry in Europe.

4.2. International law applying to cross-border space tourism

We have already indicated that space tourism in Europe is likely to cross borders, which creates a need for harmonisation of national laws. But even generally, whenever 'space tourism' involves more than one jurisdiction, international law will come into play, and the first question is, which law? Air law? Or space law? To determine this, one of the oldest questions raises its head once again: where does air end, and space begin? We will shortly address this issue and will then discuss a few other subjects that are relevant.

4.2.1. The boundary issue

From a strictly legal perspective, there is yet no clear definition of outer space, or put another way, where (and how) air space ends and outer space begins. While outer space activities have continued to develop notwithstanding this uncertainty, there are important practical reasons why a clear legal distinction between 'commercial aviation flights' and 'commercial space flights'[36] may become more pressing, given the possible advent of space tourism activities-particularly involving suborbital flights.

This is even more appropriate given the fundamental differences between air law and outer space law. The Outer Space Treaty provides that '[o]uter space…is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means'.[37] This also reflects a customary law principle evidenced by the practice of States as early as the launch of Sputnik 1.[38]

On the other hand, air law regards air space as part of the 'territory' of the underlying State. A well-established body of Treaty law confirms that 'every State has complete and exclusive sovereignty over the airspace above its territory'.[39] This is also reflected in customary international law.[40] Of course, any space tourist activities

[32] International Association for the Advancement of Space Safety, http://www.iaass.org/. The EASA paper is titled *Accommodating sub-orbital flights into the EASA regulatory system*, by Marciacq et al., downloadable at www.congrex.nl/08a11/presentations/day1_S09/S09_05_Marciacq.pdf. EASA has in fact been approached by (unnamed) potential applicants, which encouraged it to come forward with a proposed regulatory framework. See also http://www.flightglobal.com/articles/2008/10/28/317902/easas-space-tourism-approach-requires-certification.html.

[33] Cf. Marciacq et al., *supra* note 30, in heading 2.3.

[34] Marciacq et al., *supra* note 30, in heading 5.2.

[35] Regulation (EC) no. 216/2008 of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency (OJ L79/1, 19.3.2008), available at: http://www.easa.europa.eu/ws_prod/g/rg_regulations.php#BR, Article 4.4 and Annex II.

[36] R. Thomas Rankin, Note, *Space Tourism: Pack, Ugly T-Shirts, and the Law in Outer Space*, 36 Suffolk University Law Review 695, 697 (2003).

[37] Outer Space Treaty, Article II.

[38] *North Sea Continental Shelf Cases* (*Germany vs.Denmark*; *Germany v Netherlands*), 1969 ICJ 3, 230 (February 20, 1969) (separate opinion of Judge Lachs).

[39] Convention on International Civil Aviation 59 Stat 1693 (1947) (Chicago Convention), Article 1.

[40] In *Case Concerning Military and Paramilitary Activities in and against Nicaragua* (*Nicaragua v United States*) (*merits*), the International Court of Justice noted that '[t]he principle of respect for territorial sovereignty is also directly infringed by the unauthorised overflight of a

requiring a launch from earth (or an air launch such as *SpaceShipOne*) and a return to earth will also involve a 'use' of air space. In this respect, the law of air space may be relevant to the legal position.

Given the distinction in fundamental legal principles between air law and the international law of outer space, it is important to determine *what laws apply where*. There has, over the years, been controversy as to how far air space extends above the surface of the earth,[41] with none of the suggested methodologies having been accepted as a legal definition through the UNCOPUOS process.

More recent developments in domestic space legislation may, however, herald the start of a move towards a more widely recognised demarcation point.[42] This evolutionary process was given significant impetus by the inclusion of a the definition of 'outer space' in a draft document headed *Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force Against Outer Space Objects* (*PPWT*) that had been presented in January 2008 to the 65 members attending the Plenary Meeting of the United Nations Conference on Disarmament (CD) in Geneva. The *PPWT* had been developed by Russia and China, two of the major space superpowers in the world. An earlier draft had been informally circulated the previous June, resulting in comments from a number of other countries. The *PPWT* defines outer space as 'space beyond the elevation of approximately 100 km above ocean level of the Earth' (Article I(a)). Apart from the curious use of the word 'approximately'—the *PPWT should perhaps have explained* in what circumstances it would *not* be 100 km—this represents a rather revolutionary suggestion by two major superpowers, which, along with the USA, have previously tended to stifle attempts to designate a formal demarcation, primarily for strategic and political reasons. Indeed, it was only a few years ago that a Chinese Foreign Ministry spokesperson referred to outer space as the 'Fourth Territory'.[43]

Notwithstanding these developments, the threshold question remains, until the issue is determined unequivocally, what laws should apply to space tourism in the absence of an accepted demarcation between air space and outer space? Should, as seems to be happening in Europe, air law apply for part of the journey and space law then be applied at some (as yet undefined) point during the space tourism activity? Is the case different for suborbital flights and for orbital flights? And then for horizontal (single or multiple stage) take-off as opposed to vertical rocket propelled take-off? Just imagine having to apply two totally different regimes to one suborbital flight, depending on where it flies at a certain given moment, or how it takes off or lands, and having to apply perhaps yet another regime for an orbital flight; this would be highly unsatisfactory and impractical.[44]

Ideally, the development of a comprehensive and uniform legal regime encompassing the complete launch and return journey of private individuals should be preferred. However, given the long time needed to agree on a new multilateral treaty, this is not a very realistic response for the short term and will not solve the immediate problems of today's space tourism entrepreneurs.

Therefore, as an alternative, for the interim, we believe that the best approach would be to apply space law to the entire orbital or suborbital international flight, simply on the basis of the proposed function of the vehicle—namely that it involves a flight in(to) outer space.[45] However, space law does then need appropriate clarification, perhaps in the form of a code of conduct developed under the auspices of the UNCOPUOS, as has recently happened with the guidelines on debris mitigation.[46] Such guidelines could seek to harmonise the rules governing the liability of the operator towards passengers and third parties, including limits on that liability, as well as provisions to ensure safety, and could be modelled after air law, which is well equipped in this field.

4.2.2. The legal status of space tourists

The existing corpus of international space law does not refer to space 'tourists', but does contemplate space travel by 'astronauts' and 'personnel of a spacecraft'. The Outer Space Treaty does not define an astronaut but stipulates that they are 'envoys of mankind' to which States are required to render 'all possible assistance'.[47] These obligations are further developed in the Rescue Agreement which, despite the use of the term 'astronauts' in its title and preamble, refers in its substantive provisions to the rescue and return of 'personnel of a spacecraft'.[48] Moreover, the Moon Agreement confirms that 'any

(*footnote continued*)
state's territory by aircraft belonging to or under the control of the government of another state'. 1986 ICJ 14, 128 (1986).

[41] On 3 December 1976, eight equatorial States signed the Bogotá Declaration (reprinted in English in 6:2 Journal of Space Law 193 (1978)), which asserted that, in the absence of any legally determined upper limit to air space, those segments of the geostationary orbit above their territory constituted part of their respective sovereign territories. This assertion has not been accepted by other States and is not considered to properly reflect international law.

[42] The Australian Space Activities Act 1998 (Cth) (no 123 of 1998), as amended by the Space Activities Amendment Act 2002 (Cth) (no 100 of 2002), incorporates a reference to 'the distance of 100 [kilometers] above mean sea level'. This was the first example of domestic law that refers to a specific 'demarcation point' for the purposes of applying space-related regulation. Should this approach eventually be extensively adopted and followed elsewhere, it may represent evidence tending towards the eventual creation of a new customary international rule. See Steven Freeland, *When Laws are not Enough—The Stalled Development of an Australian Space Launch Industry*, 8 University of Western Sydney Law Review 79 (2004).

[43] See Steven Freeland, *The 2008 Russia/China Proposal for a Treaty to Ban Weapons in Space: A Missed Opportunity or an Opening Gambit?*, forthcoming in: Proceedings of the 51st Colloquium on the Law of Outer Space, 2009. See for the text of the PPWT, http://www.mfa.gov.cn/eng/wjb/zzjg/jks/jkxw/t408634.htm.

[44] See also Hobe, Goh and Neumann, *supra* note 20.

[45] See Bin Cheng, *International Responsibility and Liability for Launch Activities*, 20:6 Air and Space Law 297, 299 (1995).

[46] Report of the Scientific and Technical Subcommittee on its forty-fourth session, 2007, A/AC.105/890, Annex 4 at 42; available online at: http://www.oosa.unvienna.org/pdf/reports/ac105/AC105_890E.pdf.

[47] Outer Space Treaty, Article V.

[48] Rescue Agreement, Articles 1–4.

person' on the moon is to be regarded, at least by States Parties to the Treaty (currently 13), as an astronaut.[49]

It is unclear whether a commercial space tourist would (or should) fall within the 'envoy of mankind' status accorded to an astronaut. It is, however, probable that space tourists would constitute 'personnel of a spacecraft' (after all, they undergo some sort of training), bringing them within the rescue and return obligations of the Rescue Agreement, which is, after all, desirable in case of an accident, on purely humanitarian grounds—one could hardly imagine returning the astronauts and leaving the tourists behind.

Yet, the issue of the legal status of tourists should be clarified. In late 2001, the partners in the ISS reached agreement as to who was allowed on the ISS. This covered both 'professional astronauts/cosmonauts' and 'space-flight participants', which included those on commercial, scientific and other programmes, crewmembers of non-partner space agencies, engineers, scientists, teachers, journalists, filmmakers, or tourists.[50] This can be a useful model for space tourism.

4.2.3. Jurisdiction and control

The existing international law of outer space deals with issues of jurisdiction through a system of registration. Under the Outer Space Treaty, 'jurisdiction and control' over a space object and its personnel 'while in outer space or on a celestial body' is vested in the State that registers that object pursuant to the Registration Agreement.[51] The definition of a 'space object' is, however, vague.[52] Note that although in space law these provisions are rather vague, in air law, the system of registration of aircraft is well defined.

4.2.4. Safety and liability towards passengers and third parties

These are perhaps the two most important legal issues involved. The *Columbia* disaster again illustrated the hazardous nature of space travel and reinforced the need for the highest possible safety regulation standards for commercial space tourism. Of course, this should already be the case with human space travel; however the enormous costs associated with addressing every foreseeable contingency have meant that human space travel has, to date, involved trade-offs between design and what are deemed as 'acceptable' risks. One thing is certain: accidents will happen.

Not only must there be appropriate safety standards for the design, construction and operation of a space tourism vehicle, but a system of responsibility and liability must be established at the international level-supplemented by domestic law-to regulate those circumstances where, in an international context, a space tourist suffers injury, loss or damage, so as to remove uncertainties and ensure that proper risk avoidance procedures are in place.

In this regard, existing international space law is inadequate. All it does is create a State-based system of absolute liability for damage caused on earth or to aircraft in flight, and a similar system of fault liability for damage caused to other space objects in outer space or property or personnel on board.[53] Although it was contemplated that 'national activities in outer space' might be undertaken by nongovernmental entities, the Outer Space Treaty provides that responsibility will still lie with States. Even though the range of space activities and the number and type of participants has grown exponentially, this remains the position today. States are required to authorise and continually supervise national activities in outer space undertaken by nongovernmental entities pursuant to Article VI of the Outer Space Treaty. This also reflects customary international law and thus binds all States.

Following on from this 'State-oriented' system of responsibility, Article VII of the Outer Space Treaty, together with the more detailed regime in the Liability Convention, impose an international obligation of liability on the 'launching State(s)' for certain specified damage caused by a space object, on a joint and several basis.[54] This is one of the reasons behind the growing number of national space laws enacted by space faring States, the terms of which pass financial responsibility to private entities for (at least a part of) the amount of compensation for which the relevant State may be liable at the international level.

Even where damage is suffered by individuals, only the relevant State(s) can institute the Liability Convention procedures. This requires political will on the part of that State to present a claim to a launching State. To date, no such formal claim has been made. Space tourists themselves are unable to claim for compensation under the Liability Convention. While they could institute legal proceedings under national laws, there are limitations, such as sovereign immunity, that may represent a bar to a

[49] Moon Agreement, Article 10.

[50] See R. Veldhuyzen and T. Masson-Zwaan, *ESA Policy and Impending Legal Framework for Commercial Utilisation of the European Columbus Laboratory Module of the ISS*, in: The International Space Station, Commercial Utilisation from a European Legal Perspective 47, 54–55 (F. von der Dunk/M. Brus, (Eds.), 2006). See the document setting out the criteria for selection, assignment, training and certification of ISS (expedition and visiting) crew members, prepared by the Multilateral Crew Operations Panel (MCOP) of the Multilateral Coordination Board (MCB), ESA/C/IGA-CC(2001)1 of 7 September 2001 and its Annex 4. It was adopted on 28 November 2001. For the introduction of a distinction between different types of crew members, see the ISS Crew Code of Conduct, ESA/C(2000)14 of 29 February 2000, Annex. At the time of Dennis Tito, Russia had to agree to take additional insurance in case the 'tourist' would cause harm; after all tourists are less trained than professional astronauts and the chance of something going wrong is not unthinkable.

[51] Outer Space Treaty, Article VIII. See for an extensive overview of this issue, Blount, *supra* note 23.

[52] Article I(b) of the Registration Agreement provides that a space object 'includes component parts of a space object as well as its launch vehicle and parts thereof'.

[53] Articles II and III of the Liability Convention.

[54] Article 1(c) of the Liability Convention defines a launching State as follows: '(i) a State which launches or procures the launching of a space object; (ii) a State from whose territory or facility a space object is launched'. For a discussion of the terms of the Liability Convention, see Steven Freeland, *There's a Satellite in my Backyard!—Mir and the Convention on International Liability For Damage Caused by Space Objects*, 24 University of New South Wales Law Journal 462 (2001).

claim for compensation.[55] In addition, given the private contractual nature by which most space tourism activities will operate, it is likely that carefully drafted exclusion of liability clauses, or some other contractual provision analogous to the well known 'cross waiver' regime that generally applies to current commercial space activities, would be invoked.

It is preferable that, in addition to relevant domestic legislation, a uniform and comprehensive regime for passenger liability arising from space tourism activities be developed at the international level. These rules should allow for direct claims by private passengers and operate from the launch until the return to a final destination. Of course, third party liability should also be regulated.

It will be necessary to determine exactly how this new liability regime allows for effective private remedies. A starting point would be to consider not only the provisions of the Liability Convention, but also the international regime established in relation to liability for death or injury of passengers during commercial air travel. In doing so, however, it must be remembered that the regime for the airline industry was structured specifically to meet the peculiarities of that industry and, in any event, experience has shown that it would not necessarily be an ideal model for the unique characteristics and enormous costs associated with space tourism.[56]

A consideration of both legal regimes immediately gives rise to some fundamental questions. Should space tourism activities be subject to absolute liability, as is the case for certain damage caused by a space object under the Liability Convention,[57] or be based primarily upon principles of negligence, as exists under the international law of air space, although this may be a difficult concept to 'prove' in many instances? Similarly, should the quantum of the liability be unlimited, as is the case under the Liability Convention, or is it appropriate to prescribe upper limits of liability as specified in the Montreal Convention?[58] On the question of unlimited liability, there have already been calls from a leading commentator for a limited liability regime to be introduced for launching States.[59] Some may argue that space tourists voluntarily accept the inherent risks associated with space travel and that liability should therefore be limited.

Whatever the final form of the regime, the existing rules of space law, which rely solely on State responsibility and liability, are not entirely appropriate for an industry that will principally be undertaken as a private commercial venture. A new Treaty may be required to establish a system of liability that attaches to those private operators conducting space tourism activities. This new regime must also address third party liability.[60] This will also necessitate the development of an adequate space tourism insurance market.

5. Some ethical considerations

Even if we assume that the expansion of our universe (quite literally) through space tourism is a positive, almost inevitable direction for humankind, it is not only the 'hard law' provisions that require reassessment. There are complex ethical questions relevant to the direction of future developments of international (and national) space law, particularly as they apply to space tourism. A number of these are briefly raised below, although the authors acknowledge that this is an area to be considered in far greater detail than the confines of this article will permit.

5.1. What are 'appropriate' space tourism activities?

The ISS represents a first example of humankind's efforts to make the space environment part of its domain. The evolution of space tourism activities will not only make space more accessible to human beings, but will also reinforce this constant human presence in outer space. This is not of itself incompatible with the provisions of the Outer Space Treaty, provided that the rules regulating such activities ensure that the concepts set out in the Treaty are properly protected.

In this regard, many questions arise that will influence the way the international law of outer space should regulate future space tourism activities. For example, what types of space tourism 'activities' are 'appropriate'?

[55] In relation to the issue of sovereign immunity in United States courts in respect of claims under the Federal Tort Claims Act, 28 USC §§ 1346(b), 2671–80 (1994), see Lauren S.-B. Bornemann, *This Is Ground Control to Major Tom… Your Wife Would Like to Sue but There's Nothing We Can Do… The Unlikelihood that the FTCA Waives Sovereign Immunity for Torts Committed by United States Employees in Outer Space: A Call for Preemptive Legislation*, 63 Journal of Air Law and Commerce 517 (1998).

[56] The limitation of liability has meant that claimants are often tempted to sue aircraft manufacturers instead, in an attempt to obtain a higher level of compensation: Malcolm N Shaw, International Law 470 (Cambridge 5th ed. 2003).

[57] Article II of the Liability Convention provides that '[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'. However, if the damage is caused 'elsewhere than on the surface of the earth', liability only arises where the damage is due to 'fault' by those responsible for the space object causing the damage. Id, Article III.

[58] The Warsaw Convention of 1929, as amended, provides for upper limits for liability in relation to the carriage of passengers and of baggage and cargo as well as dealing with areas of responsibility and insurance. Article 20(1) exonerates the carrier from liability where it or its servants and agents 'have taken all necessary measures to avoid the damage or that it was impossible for him or them to take such measures'. The Montreal Convention of 1999 was designed to supersede the Warsaw Convention and removed the system of arbitrary limits on air carrier liability, by providing that the carrier was liable for the full amount of the damages, unless it could demonstrate that it was not negligent or that a third party was solely responsible for the damage: Montreal Convention, Article VI. See also Shaw, note 54 above at 471.

[59] See, for example, International Law Association, Report of the Seventieth Conference 209 (April 2002) (comment of C.Q. Christol).

[60] The Rome Convention on damage caused by aircraft to third parties on the surface, 310 United Nations Treaty Series 181 (1952), and the Montreal Protocol of 1978, deals with third party liability in respect of commercial air activities. It is intended 'to ensure adequate compensation for persons who suffer damage caused on the surface by foreign aircraft, while limiting in a reasonable manner the extent of the liabilities incurred for such damage in order not to hinder the development of international civil air transport'. However the Rome Convention is not widely ratified because of its low limits and its relevance is negligible. In most cases, national law will determine the compensation to third parties on the ground.

Should there be any restriction on the nature of these activities to preserve the 'integrity' of outer space? On what basis, if any, should these restrictions be determined? Would it be acceptable, for example, to allow advertising billboards to be constructed, or casinos or even brothels to be established on the moon to cater to space tourists? How do space tourism activities correlate with the underlying philosophy of international space law, namely that the exploration and use of outer space 'shall be carried out for the benefit and in the interests of all countries' and that they 'shall be the province of all mankind'?[61]

As the capability of space-related technology advances, these qualitative questions must also be addressed in order to prioritise those activities that most closely accord with the overall goals associated with humankind's ongoing endeavours in space.

5.2. Pollution of the space environment

The protection of the natural environment of outer space is an important element of the 'province of all mankind' philosophy. The international law of outer space makes some reference to environmental protection, though these provisions are neither sufficiently detailed nor rigorous when compared to UNCLOS.[62] The main provision concerning environmental protection in the Outer Space Treaty (Article IX) is ill defined and imposes only minimal obligations on States. In addition, there is currently no definition of 'space debris' under international space law and thus no mechanisms to regulate it. Relatively little has been done to tighten the legal requirements relating to the environmental protection of outer space, principally due to the significant costs associated with 'clean' space technology and practice. Nevertheless, progress has recently been made with the agreement on debris mitigation guidelines within the UNCOPUOS Scientific and Technical Subcommittee and the IADC guidelines a few years earlier.[63]

Space tourism activities will inevitably result in greater pressures on the environment of earth—there are claims that space tourist vehicles will one day become the world's primary source of carbon dioxide emissions[64]—and of space. They will lead to the pollution of previously pristine areas. The control of human activities like littering would cost relatively little in dollar terms to regulate. It is imperative that this is done to minimise disruption to the space environment.[65]

5.3. Protection of 'heritage sites' in space

As well as protecting the space environment from pollution, it is also appropriate to consider important sites in outer space that are (and will be) historically significant. Legal regulation will be required to provide for 'heritage sites' in order to protect particular areas, such as the site of the first lunar landing by humans, from accidental or deliberate damage by space tourists.[66]

An even more complex issue, whose heritage space is, will need to be reassessed in the future. How should we regard human inhabitants of future space colonies, particularly those born and who live their entire lives in outer space, perhaps in a settlement on the moon? What are their rights and how do they relate to (or differ from) those international legal rules for outer space that have evolved on earth?

These are, obviously, difficult questions and will not arise in the near future, though they represent important elements in the overall planning of an appropriate international legal regime for human activities in outer space, including space tourism. It will be important to develop comprehensive and universal ethical standards and practices to deal with the continued utilisation of space in this way.

6. Concluding remarks

The corpus of existing space law represents an important base from which to develop the legal tools to properly regulate the next stage of space activities. Yet it is not sufficient even for present purposes, let alone for the coming decades. The advent of space tourism raises many unanswered legal questions, some of which have been highlighted in this article. Other legal issues will also arise. As more space tourism (and other) activities take place, appropriate dispute resolution procedures must be agreed to deal with conflicts that will inevitably arise, both at the public and private international law level. Detailed traffic management systems must be developed.

[61] Outer Space Treaty, Article I.

[62] The United Nations Convention on the Law of the Sea (UNCLOS) provides for an express obligation to protect the marine environment and facilitates this in relation to the high seas by providing for port-state jurisdiction over pollution offences; see UNCLOS part XII, in particular Section 6.

[63] Supra note 44.

[64] George Monbiot, *Lost in Space*, The Guardian (November 13, 1999), available at: http://www.monbiot.com/archives/1999/11/13/lost-in-space/. He says on space tourism: 'It is hard to think of a better designed project for maximum environmental destruction'. See also http://www.guardian.co.uk/environment/blog/2009/may/11/travel-and-transport-carbon-emissions, where space tourism is called "one of the most extravagant and self-centred uses of a fossil fuel imaginable". In a reply, Virgin Galactic states that their concept results in "a very low-energy and low environmental impact approach to getting humans, scientific payload and eventually even small satellites into space" and will lead to an overdue industrial revolution in space, see http://www.guardian.co.uk/environment/ethicallivingblog/2009/may/18/travel-and-transport-carbon-emissions.

[65] The parties to the Antarctic Treaty have concluded a Protocol which, in part, imposes a 'polluter pays' regime. This will also be applied in relation to the 30,000 tourists to the region each year: *Deal Reached on Making Polluters Pay in Antarctica*, Terra Daily (June 17, 2005), at http://www.terradaily.com/news/antarctic-05h.html. Indeed, commercial lunar efforts have the potential to interact with artifacts from the first era of lunar exploration and legal guidelines may be needed. The issue of protection of special regions is gaining scientific attention, for instance within COSPAR. See http://www.space.com/scienceastronomy/080725-google-xprize.html.

[66] Article 7(3) of the Moon Agreement allows the designation of areas of the moon and other celestial bodies having 'special scientific interest' as 'international scientific preserves for which special protective arrangements are to be agreed upon'.

A comprehensive legal framework must be established at the international level to reflect the wishes of the wider (global) community and to provide certainty.

At the same time, however, the broader philosophical and ethical aspects of human activities in outer space, indeed the place of human beings in the universe, demand that we continually reassess the *why* and *what* in relation to our ongoing exploration and use of outer space.

Moreover, just as our use and exploration of outer space is impacted by terrestrial concerns—including economics, politics, social and fundamental human rights—it also serves as a model for our future activities on earth as well. There are many lessons that we can learn from our (over)exploitation of the earth's natural resources, our thirst to have the biggest and best in the fastest possible time. Should we adopt this 'efficiency' approach to the exploitation of outer space—doing it as quickly as we can, irrespective of the longer-term consequences?

Or, rather, should our future activities in outer space—and ultimately on earth—be considered and measured, taking into account the differing expectations and capabilities of the various countries on earth.

In this way, how we adapt to the rapidly developing spheres of space-related technology will be important not only for outer space itself, but also (possibly) for future generations living on earth. Outer space belongs to all of us. Our use of it should reflect underlying notions of cooperation and shared benefit, which must remain as cornerstones in this next phase of human achievement. Perhaps also this will shape our future life on earth.