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International Space Law in Transformation: Some Observations

Glenn Harlan Reynolds

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As we enter the twenty-first century, the space law framework created during the Cold War era of the mid-twentieth century is under some strain. It appears likely that the most important new issues facing space law will bear little resemblance to the questions that received the most attention during the previous century.

Quite a few new issues will rear their heads over the coming decade or two, but here are four that seem of particular importance: space tourism, space militarization in a non-Cold War context, space environmental issues relating to Mars, and the legal character of space elevators. I will thus discuss each of these in turn, followed by some observations on related topics of interest.

I. SPACE TOURISM

The very term "space tourism" invited giggles just a few years ago. Space was the domain of high-status government employees such as astronauts and the occasional junketing Congressman, not a place for pleasure jaunts by the citizenry. But now that is changing.

Thanks to the innovative work of the X-Prize Foundation, quite a few private entities have gotten into the space business, and the prospects for future space tourism look bright.[1] Burt Rutan's *SpaceShipOne* flew two successive crewed flights and won the ten million dollar prize, but it was only one of several competitors. As Max Boot noted in the *Los Angeles Times*:

> Where SpaceShipOne is leading, plenty are eager to follow. Richard Branson announced that Virgin Atlantic would license Rutan's design to

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1 Buzz Aldrin and Taylor Dinerman, *2005: A Space Odyssey*, Wall St J A10 (Jan 12, 2005); Rick Gershman, *Rediscovering the Final Frontier*, St. Petersburg Times 22W (Dec 23, 2004).

> take tourists into space in 2007. Several other private firms are also building suborbital spacecraft. Still others are working to collect a potential $50-million prize for the first private manned vehicle to orbit the Earth.
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> The promoter of the orbital award, hotel tycoon Robert Bigelow, is also working to loft his own space station, which would be available to rent. Who knows? Maybe we will finally achieve what the movie "2001: A Space Odyssey" took for granted when it was released in 1968: regular passenger flights to the moon. All of that might have sounded like pie in the sky a few weeks ago. Not anymore.[2]

No, not anymore. Though we have seen false starts in the commercial space area before, space tourism is looking like an idea whose time has come. Space proponents hope and expect that the growth of space tourism, starting with suborbital flights and eventually extending to orbital stays and perhaps even lunar excursions, will produce sufficient traffic (and attention to cost lowering) to produce dramatic improvements in access to space. Costs to orbit currently run in the thousands of dollars per pound, but could conceivably be slashed to the dozens per pound.

For those who, like me, see the expansion of human settlement throughout the solar system and beyond as an inevitable (and essential) part of humanity's future, this is a welcome development.[3] But it is not a development without legal complications.

Within the American domestic sphere, space tourism has already created some dispute. The pre-2004 version of the Commercial Space Launch Act of 1984[4] did not address space tourism directly. As I write this, new legislation aimed at encouraging space tourism has passed into law.[5] The Federal Aviation Administration's regulatory philosophy to date has revolved around protecting

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2 Max Boot, *Space: The Final Free Market,* LA Times B13 (Oct 7, 2004).

3 I am not the only one to feel this way, as Congress has weighed in to the same effect with the Space Settlements Act, Pub L No 100-685, Title II, § 217, 102 Stat 4094 (1988), codified at 42 USC § 2451 (2000). This Act explicitly endorsed the "extension of human life beyond Earth's atmosphere, leading ultimately to the establishment of space settlements," and provided for biannual reports by NASA regarding its efforts to promote this goal.

4 49 USC §§ 70101–70121 (2000).

5 See Commercial Space Launch Amendments Act of 2004, Pub L No 108-492, 104th Cong (2004), 118 Stat 3974, reprinted in 2005 USCCANN 3974–3983. HR 5382, available online at <http://www.house.gov/science/press/108/ROHRAB_095_xml.pdf> (visited Jan 19, 2005). See also Alan Boyle, *Space Tourism Legislation Makes Comeback*, MSNBC.com (Nov 22, 2004), available online at <http://msnbc.msn.com/id/6540267/> (visited Feb 21, 2005). For more on these issues, see Glenn Harlan Reynolds, *Good News and Bad News for Commercial Space,* TechCentralStation.com (Oct 12, 2004), available online at <http://www.techcentralstation.com/101204L.html> (visited Feb 21, 2005). For related thoughts on waivers of liability within the context of the private space launch industry, see Kim B. Watson, *Have the Courts Grounded the Space Launch Industry? Reciprocal Waivers and the Commercial Space Launch Act*, 39 Jurimet J 45 (1998).

third parties from the risks of, for example, falling spacecraft. Risks voluntarily assumed by passengers receive far less attention. The new legislation would codify this sensible approach into law.[6]

Beyond these questions of American domestic law—though those are likely to be echoed in the legal systems of other countries that pursue space tourism's revenues and technological stimulus—are some questions of international law raised by space tourism and the more general changes it foreshadows. The 1967 Outer Space Treaty,[7] and the overall body of space law that developed in its wake,[8] poses no barrier to space tourism. But even a casual reading of the Outer Space Treaty and related agreements such as the Rescue and Return Treaty[9] suggests that the drafters of those documents envisioned a different sort of world, one in which space travel was a largely governmental endeavor, dominated by scientists, astronauts, and other functionaries. Though, technically, space tourists will qualify as "envoys of mankind" under the Outer Space Treaty, it is hard to believe they are what the drafters had in mind. This is as much a question of mood as of black-letter law, but it is not without relevance for all that, as it may lead to sharper distinctions in the future.

The Cold War-era space treaties were written for a time in which governments—and quasi-governmental enterprises like COMSAT and INTELSAT[10]—were the prime movers in space activity. That is already changing on the civilian side and likely to change on the military side.

II. MILITARY APPLICATIONS IN SPACE

Despite efforts to make outer space a demilitarized zone, military use of space has been substantial since the beginning of space exploration. (And,

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6 Consider Laura Montgomery, *Space Tourism and Informed Consent: To Knowingly Go*, 51 Fed Law 26 (July 2004) (analyzing an earlier version of the legislation).

7 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (1967), 18 UST 2410 (1969).

8 The classic history of the 1967 Treaty's drafting and purposes is Paul G. Dembling and Daniel M. Arons, *The Evolution of the Outer Space Treaty*, 33 J Air L & Comm 419 (1967). See also Glenn H. Reynolds and Robert P. Merges, *Outer Space: Problems of Law and Policy* 25–93 (Westview 2d ed 1997) (describing growth of international space law).

9 Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (1968), 19 UST 7570 (1969).

10 See Reynolds and Merges, *Outer Space* at 74, 219–21 (cited in note 8) (describing the Communications Satellite Corporation (COMSAT) as "a nongovernmental entity whose activities are authorized and regulated by the United States federal agencies pursuant to federal statutes and regulations" and INTELSAT as "an international consortium providing satellite communications among nations").

indeed, since before the beginning, as US interest in military uses of outer space dates back to the end of World War II.)[11]

More recently the United States military has been looking at somewhat more dramatic plans. A new Air Force document entitled *Counterspace Operations*,[12] which calls for a more aggressive United States posture, has received considerable attention.

Under the doctrine set forth in *Counterspace Operations*, the United States Air Force claims the right to attack enemy satellites or ground stations—or, and this is the more controversial part, satellites and ground stations of neutral third countries that are being used by enemy nations—in order to secure a position of "space monopolization" for United States forces. Not surprisingly, this approach has produced some criticism, particularly in the context of the European *Galileo* positioning system, which would deny the US its current ability to deprive adversaries of precise positioning information in time of war.[13]

Writing in *Arms Control Today,* Michael Krepon argues that militarizing outer space is a terrible idea:

> If the United States leads the way in flight-testing and deploying new anti-satellite (ASAT) weapons, other states will surely follow suit because they have too much to lose by allowing the Pentagon sole rights to space warfare. U.S. programs will cost more and be far more sophisticated than the ASAT weapons of potential adversaries, who will opt to kill satellites cheaply and crudely. The resulting competition would endanger U.S. troops that depend on satellites to an unprecedented degree for battlefield intelligence, communication, and targeting to win quickly and with a minimum of casualties.
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> Space warfare would have far-reaching adverse effects for global commerce, especially commercial transactions and telecommunication services that use satellites. Worldwide space industry revenues now total almost $110 billion a year, $40 billion of which go to U.S. companies. These numbers do not begin to illuminate how much disruption would occur in the event of space warfare. For a glimpse of what could transpire, the failure of a Galaxy IV satellite in May 1998 is instructive. Eighty-nine percent of all U.S. pagers used by 45 million customers became inoperative, and direct broadcast

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11 Consider Paul B. Stares, *The Militarization of Space: U.S. Policy, 1945–1984* (Cornell 1985).

12 United States Air Force, *Counterspace Operations*, Air Force Doctrine Document 2.2.1 (Aug 2, 2004).

13 See, for example, *US Could Shoot Down Euro GPS Satellites if Used by China in Wartime: Report*, Space Daily (Oct 24, 2004), available online at <http://www.spacedaily.com/news/milspace-04zc.html> (visited Feb 21, 2005); Oliver Morton, *Europe's New Air War*, Wired (Aug 2002), available online at <http://www.wired.com/wired/archive/10.08/airwar.html> (visited Feb 21, 2005).

> transmissions, financial transactions, and gas station pumps were also affected.[14]

Krepon's piece makes a number of good points, and having written something very similar in 1992, I suppose I am in a poor position to argue. Here's what I wrote then:

> Military battles in space are unlikely to occur because outer space is already too valuable as a center of commercial activity. Satellite communications alone are a multibillion-dollar-per-year industry, and the value of satellite communications in tying together global industries is far greater than the dollar figure suggests. A major disruption of satellite communications—a near-certain side effect of significant space combat, even among automated devices—would bring global business to a near-standstill in short order, with phenomenal costs. And satellite communications is only one of the many civilian and commercial activities that already take place in outer space, although not necessarily the most valuable activity over the long term.

In short, outer space makes no more sense as an arena for "clean" warfare than do the floors of the world's stock exchanges, and the ultimate consequences of such warfare would be similar.[15]

But there are some differences. The Cold War was just drawing to a close when I wrote those words, and the paradigm case for space warfare back then still involved a conflict of the Cold War variety, between adversaries who both had something to lose and who both knew it.

Today's environment is rather different. The biggest threat to US space assets is probably not Russia, or even China: It is some rogue nation or group trying to create economic disruption at low cost. An attack on satellites might produce a lot of economic damage, and—since it wouldn't directly kill anyone—might even do so without risking the kind of swift and sharp response that the Taliban encountered after the 9/11 attacks on America. And considering that today's Islamist terrorists oppose modernity and the worldwide spread of Western (and especially American) culture, that sort of attack looks more plausible: Despite the growth of *Al Jazeera*, satellites are still largely a tool for the dissemination of Western culture. And though bringing down satellites is not child's play, it is not so hard that it is beyond the capability of well-funded groups or even small states. North Korea, I suspect, has the resources to bring down a lot of satellites, either through crude means such as lofting gravel into intersecting orbits or through exploding nuclear weapons in outer space,

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14 Michael Krepon, *Weapons in the Heavens: A Radical and Reckless Option*, Arms Control Today (Nov 2004), available online at <http://www.armscontrol.org/act/2004_11/Krepon.asp#krepon> (visited Feb 21, 2005) (footnotes omitted).

15 Glenn H. Reynolds, *Outer Space and Peace: Some Thoughts on Structures and Relations*, 59 Tenn L Rev 723, 727 (1992).

damaging satellites via electromagnetic pulse. As access to space becomes broader and cheaper, such capabilities will become more widely accessible.

This means that for those of us in the United States, and perhaps the industrialized world generally, the big question is not whether to have a military presence in space, but rather what kind we should have. Arguably, we should be worrying more about defending against rogue threats that cannot be deterred by a symmetric response, meaning that government antisatellite ("ASAT") and antiballistic missile ("SDI") plans are just as stuck in the Cold War paradigm as the examples quoted above. But so is an "arms control" approach that assumes that treaties and international agreements—or simply the United States' force-of-example—can prevent military action in space.

Just as the Air Force seems to think of space warfare issues in ways that—shockingly—produce more missions for the Air Force rather than in ways (such as regulations requiring commercial-satellite hardening or backups) that do not, the arms control community tends to think of space warfare issues in ways that involve arms control. But that, too, is probably missing the point. Just as with the Air Force, these groups need to think more imaginatively. Another illustration of that phenomenon can be found in this statement: "Plans for a 'thin constellation of three to six spacecraft' in orbit, which would target enemy missiles as they took off or landed, are planned . . . [T]he 1967 Outer Space Treaty, which outlaws the use of weapons in orbit, will be ignored."[16]

Actually, the Outer Space Treaty only outlaws the placing of nuclear weapons "or any other kinds of weapons of mass destruction" in orbit, and the establishment of military bases or fortifications on the moon and other celestial bodies.[17] It does not forbid peaceful or defensive uses of outer space. It is rather troubling to see this distinction so frequently ignored by opponents of space militarization, as these omissions do not improve their credibility.[18]

I am an agnostic on the value of space-based missile defense. But the best arguments against it are practical—will it protect us from the kinds of threats we face, or not—rather than legal.[19] And the answers to those questions are likely to

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16 Mark Townsend, *US Ready to Put Weapons in Space*, Guardian (Nov 7, 2004), available online at <http://www.guardian.co.uk/space/article/0,14493,1345460,00.html> (visited Feb 21, 2005) (quoting Theresa Hitchens of the Center for Defense Information).

17 The 1967 Outer Space Treaty, art IV (cited in note 7).

18 For another example of sloppiness where the Outer Space Treaty is concerned, see Philip Ball, *The New Race to Space*, Nature (Sept 27, 2004).

19 On the legal front, it is worth noting that President Jimmy Carter once opined that an attack on a US satellite would be treated as an act of war. See 14 Weekly Comp Pres Doc 1135, 1136 (June 20, 1978) ("Purposeful interference with space systems shall be viewed as an infringement upon sovereign rights."). Carter appears to have had an unprovoked attack in mind, though, and the legality of an attack on satellites that are aiding an enemy belligerent seems a somewhat different

be found outside the now obsolete Cold War frameworks, too. I hope that both our military and its critics will take a more original approach to these questions in the future.

For the interim, here are some observations. First, the growth of private spaceflight, and space tourism, mentioned earlier is going to transform this area as well. Although private spacecraft are unlikely to make useful weapons in and of themselves (crashing Burt Rutan's *SpaceShipOne* into a skyscraper would do far less damage than a similar attack with an airliner, as *SpaceShipOne* is smaller, carries less fuel, and uses a nonexplosive "hybrid" rocket fuel anyway), they will expand access to space in ways also likely to expand opportunities for mischief. Could a *SpaceShipOne*-type craft mount and launch an antisatellite weapon? Probably. And as the technology for such peaceful spacecraft advances, the inevitable cost-lowering and capability-enhancing results will make space technology available to nonstate actors to a much greater degree than it is now—just as the cost-lowering and capability-enhancing aspects of the personal computing revolution have made computer capabilities far more widely available to both good guys and bad.

Would a US antisatellite capability help in these circumstances? That is not clear to me, but to the extent that it does help it will only be in circumstances where it can take rapid action against an unfolding threat. If its only value is as a deterrent, then it is much less valuable, as terrorist groups and rogue nations are unlikely to have comparable assets. A threat to shoot down a satellite is no deterrent to someone who has no satellites.

This may, in fact, be a case where the multilateralists' argument looms strong. At least, it seems possible that effective diplomacy and multilateral security arrangements may do more to promote security, by limiting the ability of terrorist groups and rogue states to operate at all, than antisatellite weapons can do to prevent such attacks. Indeed, although other efforts to isolate rogue states have met with limited success, with second-tier powers often willing to cheat or evade sanctions in order to win sales or obtain geopolitical influence (a phenomenon that bodes poorly for *Galileo*), it is possible that the broad importance of satellite communication—especially commercial satellite communication—to national economies might produce a different outcome.

This is also an argument for broadening nations' participation in civilian space activities, a point that has been made before. The more nations and

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issue. For more on this issue, see Comment, *The Legality of Antisatellites*, 3 BC Intl & Comp L Rev 467 (1980); Nina Tannenwald, *Law versus Power on the High Frontier: The Case for a Rule-Based Regime for Outer Space*, 29 Yale J Intl L 363 (2004); Elizabeth Seebode Waldrop, *Integration of Military and Civilian Space Assets: Legal and National Security Implications*, 55 AF L Rev 157 (2004); Reynolds and Merges, *Outer Space* at 82–93 (cited in note 8) (reviewing arms control provisions of the 1967 Outer Space Treaty).

organizations that have a stake in the peaceful use of outer space, the more nations and organizations available to help forestall activity that might imperil such uses.[20]

III. SPACE ENVIRONMENTAL ISSUES

As the Bush Administration looks toward a move to send humans to Mars, space environmental issues are rearing their heads. Recent data from the *Opportunity* rover has led some scientists to revise their opinions of the likelihood that Mars may continue to harbor life:

> The search for life on Mars, now more than a century old, is still not finally resolved. But the odds that life existed there and may still exist are shortening, according to planetary experts, Dr Kargel said.
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> . . .
>
> The risks are twofold: probes sent from Earth may contaminate Mars with terrestrial bacteria, wrecking future studies of Martian life; or, more important, bacteria brought back from Mars may contaminate the Earth with unpredictable effects.
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> . . .
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> Although the presence of water on the red planet can be considered proved, of life there are only hints. One is the presence of the gas methane, which might be produced by forms of life. On Earth, life can exist in areas as acidic and salty as Meridiani Planum, where *Opportunity* landed—examples are the ancient mines of Rio Tinto in Andalucia, Spain, or the salty Permian Basin in Texas. But few earthly species survive in environments that are at the same time very cold, very acidic, and very salty—and none that do survive in such conditions produce methane.
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> "But maybe on Mars they do," says Dr Kargel, the author of a recent book on the latest ideas about Mars. Or maybe, he suggests, the organisms that produced the Martian methane live in areas more hospitable than Meridiani Planum.[21]

The likelihood that Mars life could contaminate Earth seems low, but not impossible, and efforts to address that sort of contamination are underway. This is a legal obligation, as well as a practical one: The Outer Space Treaty requires its adherents to avoid "harmful contamination" of the earth and other planets.[22] Whether Martian bacteria would harm the Earth's biosphere is uncertain, but

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20 Consider Glenn H. Reynolds and Robert P. Merges, *The Role of Commercial Development in Preventing War in Outer Space*, 25 Jurimet J 130 (1985) (arguing that the best way to prevent outer space from becoming a "barren battlefield" is to promote its commercial development).

21 Nigel Hawkes, *The Threat from Life on Mars*, Times (London) (Dec 3, 2004), available online at <http://www.timesonline.co.uk/article/0,,3-1385572,00.html> (visited Feb 21, 2005).

22 The 1967 Outer Space Treaty, art IX (cited in note 7).

while the risk is almost certainly low, the magnitude of harm that could conceivably result from such contamination is literally incalculable. This would seem to call for considerable care and research before human missions depart for Mars. On the upside, Martian meteorites have already been found on Earth, suggesting that whatever cross-contamination is possible may have already happened.

Contamination, of course, can go both ways. The transfer of Earth bacteria to Mars lacks the potential-for-catastrophe aspect of transfers in the reverse direction. On the other hand, it's likely—indeed, almost certain—that a human mission to Mars would result in such contamination. Spacecraft sent to Mars are meticulously sterilized,[23] but ridding human beings of microorganisms is not so easy. Of course, the Outer Space Treaty bans only "harmful contamination," and whether the spread of earth life to Mars counts as "harmful" is highly debatable.

In fact, there are many who plan to introduce Earth life to Mars with the intent of *beneficial* contamination, a process known as "terraforming."[24] The ultimate goal is to give Mars an Earth-like (or at least a *more* Earth-like) climate, so that eventually human beings will be able to live on the surface without artificial assistance. Such interventions should be done carefully (and we are not ready to begin them now), but there seems to me to be no reason to believe that the terraforming of Mars would violate international law, or pose any problems of environmental ethics, assuming that it were undertaken in a conscientious manner. This has been explored with considerable insight and sensitivity in a recent article by Robert D. Pinson,[25] but there is room for additional discussion. And, fortunately, considerable time for such discussion remains as well.

IV. SOME OTHER ISSUES

Some new technologies may revive old subjects. The 1976 Declaration of Bogota represented an attempt by equatorial countries to lay claim to geostationary orbits which, by their nature, are above the equator.[26] That claim found little purchase, but equatorial countries' positions may change plans for so-called space elevators (also known as "beanstalks") as they continue to

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23 See *Planetary Protection for Solar System Exploration*, Jet Propulsion Laboratory, available online at <http://planpro.jpl.nasa.gov/fctshtss.htm> (visited Feb 21, 2005) (describing sterilization procedures).

24 Consider Martyn J. Fogg, *Terraforming: Engineering Planetary Environments* (SAE Intl 1995); Robert Zubrin, *Entering Space: Creating a Spacefaring Civilization* (Penguin Putnam 1999) (describing a particular terraforming scheme).

25 Robert D. Pinson, *Ethical Considerations for Terraforming Mars*, 32 Envir L Rep 11333 (2002).

26 ITU, Broadcasting Satellite Conference, Doc No 81-E Annex 4 (Jan 17, 1977). The text can also be found at 6 J Space L 193 (1978).

progress. A space elevator is just that—a cable extending from the Earth's surface—necessarily along the equator—to geosynchronous orbit, allowing travel to space on far more economical terms than rocketry permits. As a recent report observes:

> Long imagined by science-fiction writers but seen by others as hopelessly far-fetched, the space-elevator concept has advanced dramatically in recent years along with leaps forward in the design of carbon nanotubes. Using the lightweight, strong carbon material, it's feasible to talk of building a meter-wide "ribbon" that would start on a mobile ocean platform at the equator, west of Ecuador, and extend 62,000 miles up into space.
>
> An elevator could be attached to this ribbon to ferry materials such as satellites and replacement parts for space stations—or even people—up into space. The project could become a reality as soon as 15 years from now, experts say.
>
> "Technically it's feasible," said Robert Cassanova, director of the NASA Institute for Advanced Concepts. "There's nothing wrong with the physics."[27]

If cargoes are to be hauled into space from the equator, equatorial countries will be likely to get a piece of the pie, and the old "where space begins" question will appear once more.[28] The Outer Space Treaty, and such related agreements as the Liability and Registration Conventions,[29] speak of "launching states" and tend to presume that anything in outer space has been, well, launched. A space elevator, on the other hand, is simply an extension of the

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27 Steve Kettman, *To the Moon in a Space Elevator?*, Wired News (Feb 4, 2003), available online at <http://www.wired.com/news/technology/0,1282,57536,00.html> (visited Feb 21, 2005). See also Steven Cauchi, *It's a Small World after All*, The Age A3 (Dec 9, 2004):

> Meanwhile, by 2018, the US company Liftport, with NASA's backing, is aiming to build the first space elevator, in essence a superstrong cable stretching from an orbiting satellite to the ground. Mechanised "lifters" will hoist themselves up the cable and carry payloads into orbit. But the only material that's strong enough to build such a cable—albeit produced so far only in short lengths—is a nano-engineered material called carbon nanotubes.

Brad Stone, *Climbing a Ribbon to Space*, Newsweek 64, (Oct 25, 2004):

> [T]he space elevator is now the stuff of NASA studies, academic research and business plans. In 1999 NASA gave a half million dollars to former Los Alamos physicist Bradley Edwards to develop a scenario for using the new carbon material in a space elevator. Edwards envisioned solar-powered robots ascending a three-foot-wide carbon-nanotube ribbon at 120 miles per hour, reducing the cost of getting materials to orbit from $10,000 per pound to just $100. All the technology, Edwards argued, was attainable within two decades. NASA was intrigued.

28 Consider Stanley B. Rosenfield, *Where Air Space Ends and Outer Space Begins*, 7 J Space L 137 (1979) (surveying debate).

29 Convention on International Liability for Damage Caused by Space Objects (1972), 24 UST 2389 (1974); Convention on Registration of Objects Launched into Outer Space (1975), 28 UST 695 (1978).

Earth's surface and would seem—in the absence of some agreement to the contrary—to possess the legal characteristic of whatever its bottom end is attached to. Objects that depart the elevator into Earth orbit may be regarded as having been "launched," but the elevator itself would not seem to fit that description. That means that it arguably would not count as a "space object" at all, for though that term is left suitably ambiguous in the Outer Space Treaty, it is easy to imagine an argument that an object that has not been launched cannot be a space object. I am inclined to disagree, and to think that any object that is *in* space is a space object, but the matter is not beyond doubt.

Another issue that may present itself has to do with the legality of the so-called "Orion" drive spacecraft. Orion was the name of a secret military spacecraft that used small atomic bombs for propulsion. Work on the project reached the point of test flights using a scale model, and has been recently recounted at length by George Dyson, son of physicist Freeman Dyson who worked on the project.[30]

The Orion spacecraft looked promising, capable of launching enormous payloads into space, and moving them quite rapidly once there, using crude but effective technology. It was abandoned because of environmental concerns and in particular because the 1963 Limited Test Ban Treaty prohibited atomic explosions in Earth's atmosphere or in outer space.[31]

But although the United States is a signatory to the Test Ban Treaty, other nations, such as China, are not, and the opportunity to leapfrog ahead of competitors that an Orion drive might offer is likely to prove tempting to them, and even to nations that *have* acceded to the Test Ban Treaty. Should the space race heat up again, this may become an issue.

If so, the legal questions are unsettled. The 1967 Outer Space Treaty prohibits nuclear weapons in orbit,[32] and that principle has, at least arguably, become one of customary law such that it binds even nonsignatories (though nearly all nations are parties to the 1967 Treaty). But "weapons" is a term of art. A nuclear bomb for the destruction of cities is a weapon. But is a nuclear explosive intended for spacecraft propulsion a weapon? Or simply a "device?" It seems quite plausible to me—and certainly plausible enough to satisfy a nation looking for legal cover—that the ban on nuclear weapons in orbit does not extend to such a circumstance. Certainly this issue, too, is not free from doubt.

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30 George Dyson, *Project Orion: The True Story of the Atomic Spaceship* (Henry Holt 2002); see also Freeman Dyson, *Disturbing the Universe* 107–17 (Harper & Row 1979).

31 Multilateral Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water (1963), 14 UST 1313 (1964).

32 The 1967 Outer Space Treaty, art IV (cited in note 7).

V. CONCLUSION

Indeed, though many issues of space law are, in fact, largely free from doubt, the discussion above should serve to illustrate that many more remain open for debate. I hope that this brief survey of some of the issues that I think important will serve to spark more thinking, and writing, on this subject in the future.