Space ethics and protection of the space environment

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Abstract

The construction of the International Space Station in low Earth orbit and the formulation of plans to search for life on Mars indicate that mankind is intent on making the space environment part of its domain. Publicity surrounding space tourism, in-space ‘burials’ and the sale of lunar ‘real estate’ suggests that, some time in the 21st century, the space environment will become an extension of our current terrestrial business and domestic environment. This prompts the question of our collective attitude towards the space environment and the degree to which we should regulate its use and protect it for future generations. This article offers a pragmatic view of an ethical code for space exploration and development, as far as it relates to the protection of the space environment.

1. Introduction

The exploration of the space environment—by robotic and manned missions—is a natural extension of mankind’s desire to explore our own planet. Likewise, the development of the space environment—for industry, commerce and tourism—is a natural extension of our current business and domestic agenda. Unfortunately, this brings with it the ability to pollute, degrade and even destroy aspects of the space environment.

Space exploration and development have been underway for some 45 years, since the launch of Sputnik 1 in October 1957, and few would doubt their importance and impact on society. In a pragmatic sense, space development provides employment and opportunities for wealth creation, while in a philosophical sense it provides an outlet for mankind’s inherent desire to explore and conquer new environments [1].

For the most part, the history of space exploration and development is regarded as a triumph of mankind over the space environment, first in providing access to it and second in surviving its extremes of temperature, radiation and other characteristics. Relatively little consideration has been accorded to the space environment itself in terms of the detrimental effects of space exploration and development, and relatively few practitioners consider the subject worthy of consideration.

Gradually, however, protection of the space environment is beginning to appear on the space community’s agenda, as increasing numbers of space professionals begin to consider mankind’s collective attitude towards the space environment.

2. The value question

By analogy with the early days of terrestrial environmentalism, we appear to be in the very early stages of realisation that the space environment has a value, and can be detrimentally affected by our activities.

Indeed, in some ways, the space environment is more fragile than the Earth’s. Whereas the terrestrial environment has proved itself remarkably resilient, and able to regenerate once a destructive mechanism has been removed, parts of the space environment do not possess that advantage. For example, an orbit made inaccessible by a chain reaction of debris collisions could, depending on its altitude, remain inaccessible for millennia. Likewise, a planetary body such as the Earth’s Moon, which has no appreciable atmosphere, no weather and negligible tectonic activity, has no facility for environmental renewal. Unless we actively disturb them, the hardware left by the Apollo astronauts, and their footprints, will remain intact for millennia.

However, to most people outside the space community—including otherwise intelligent and professional individuals—space is a limitless, alien void populated by...
huge and indestructible stars, a handful of barren planets and swarms of potentially dangerous comets and meteors. The space environment is hardly in need of protection, they might say; if anything, we on Earth are the ones in need of protection!

Although those in the space community may have a more informed view than those outside, the majority is likely to need some persuading that the space environment is worth protecting for its own sake—for example, because parts of it may harbour simple forms of alien life, because they contain unique physical formations, or simply because they are beautiful.

The question is one of perceived value—and the answer lies in pragmatism. In pragmatic terms, the space environment is valuable because it has a use for commercial applications. So if, for example, geostationary orbit became unusable because of a build up of debris, there would be a significant financial impact on satellite operators.

Of course, the space environment is also valuable from a scientific perspective and scientists have a vested interest in maintaining its relative purity (at least for the course of their study). Planetary scientists, for instance, are concerned about potential contamination of planetary bodies by visiting spacecraft, while ground-based astronomers are concerned at the potential disruption to observations at both optical and radio wavelengths from orbiting spacecraft.

The issue for industrialists and scientists alike is that current attitudes could prejudice future activities. The potential of the debris-clogged orbit or the contaminated canyon are simply different manifestations of the same lack of understanding and appreciation; both eventualities call for protection of the respective resource.

In addition to the pragmatic and aesthetic viewpoints, there is a philosophical consideration to the value question. It can be argued that the space environment is valuable because it represents freedom, by providing an almost unlimited expanse for mankind to explore, understand and, if he so wishes, to conquer. So if, for some reason, a part of that expanse—such as a planetary surface—became inaccessible, a part of that freedom would be lost. Placing a value on footprints and historic sites of exploration is difficult, but if it can be done for the Earth, it can be done for the Moon.

Whether one’s stance is pragmatic or philosophical, the logic is clear: if the space environment is valuable, it is worthy of protection. The question is, of course, ‘to what extent should we protect the space environment?’ Should we regulate its use to protect it for future generations, or should we simply continue the laissez faire attitude of previous generations?

It is questions such as these—the ‘should we’ questions—that have motivated some space professionals to consider drafting a code of ethics for the future development of space.

3. Space ethics

A typical English dictionary defines ethics as “the philosophical study of the moral value of human conduct, and of the rules or principles that ought to govern it”, and “a code of behaviour considered correct, especially that of a particular group, profession, or individual” [2].

Obviously, if a code of ethics for space exploration and development is to be developed, it should be one that will be adopted by the space profession. At present, the coverage and terms of reference of this code are undefined, but it is the contention of this author that an underlying theme of the code should be protection of the space environment.

One of the early steps towards the formulation of an ethical code for space exploration and development should be the demystification of ‘space ethics’, a key prerequisite for broadening the constituency for the discussion. To this end, space ethics can be summarised as “what we should and shouldn’t do in space”. Of course, this makes it seem like an immense and unbounded subject, but that is, in effect, what it is: ethical considerations colour almost everything we do, at one level or another.

We are familiar, for example, with ethical codes in medicine and biotechnology, which deal directly with people, and in various branches of engineering, mainly related to ‘health and safety’ issues. The concept of an ethical code relating to an environment is less familiar, although an enhanced understanding and appreciation of the terrestrial environment has brought about a change. For example, it would no longer be considered ethical—at least in most people’s minds—to develop an industrial process which seriously polluted the atmosphere, significantly depleted the ozone layer or rendered large tracts of land or sea uninhabitable.

The Rio Summit on the environment marked an interesting development in our collective responsibility, but the difficulties involved in reaching agreement on the necessary measures show how politics and nationalism often stand in the way of good intentions and good practice. Nevertheless, it ought to be possible to extend this philosophy of environmental protection to space.

In terms of space exploration and development, space ethics would cover, for example, the impact of our actions in space on each other, on each other’s property, on the Earth (which already benefits to some extent from our protection), and on the space environment itself.

The challenge, in terms of protection of the space environment, is the conception of a sustainable and
environmentally aware model for space exploration and development. Considering the importance of space in society, it will be crucial to engineer a balance between unbridled exploitation and overbearing protection.

4. Theory or practice?

It is apparent that the difficulties associated with achieving a balance between exploitation and protection are significant. How do we balance the rights of a developer to mine the Martian surface and those of a scientist to examine a pristine alien environment? Perhaps the compromise of allowing archaeologists a limited period of excavation prior to laying a building’s foundations offers a suitable model.

This reference to examples, both terrestrial and extraterrestrial, highlights an important point in deriving an ethical policy. There is a danger in the discussion of ethics—perhaps because of its nature as a non-science subject—that consideration is confined to the philosophical aspects, thus excusing those involved from providing practical solutions to the problems that emerge. The fact that mankind has already affected, and arguably damaged, the space environment transports the discussion beyond the philosophical realm, as illustrated by the following list of examples of our impact on the space environment.

- project West Ford/Midas 6, 1963: cloud of 18 mm copper dipoles at 3600 km;
- debris from spacecraft and upper stage explosions in LEO;
- debris from launch vehicle separation devices in LEO and GTO;
- micro-debris in LEO (e.g. spacecraft paint and thermal insulation, and metallic particles from solid propellant motors);
- growing population of defunct satellites in GEO-graveyard orbits;
- impact debris of spacecraft on Moon (e.g. Luna, Ranger, Lunar Orbiter, Apollo, Lunar Prospector);
- materials (including trash) ejected from Apollo lunar modules before lift-off;
- impact debris of Saturn SIVB rocket stages on Moon;
- similar debris (e.g. jettisoned covers) on surfaces of Venus and Mars.

So, in the same way that medical ethics concerns ‘real world issues’, such as organ donation, assisted conception and cloning, a policy of space ethics must evolve by addressing actual issues. Any attempt to derive a code of ethics from a philosophy is missing the point: the code must be an operational tool, not simply a list of postulates. Moreover, time is of the essence. The construction of the International Space Station in low-Earth orbit and the formulation of plans to search for life on Mars—one day by means of manned missions—indicate that humanity is intent on making the space environment part of its domain. Publicity surrounding space tourism, in-space ‘burials’ and the sale of lunar ‘real estate’ suggests that, some time in the 21st century, the space environment will become an extraterrestrial extension of our current business and domestic environment.

The fact that an automated rover, controlled by earthbound theme-park patrons, could be trekking across the lunar surface within the decade makes consideration of any restrictions on its exploration relatively urgent. Even if the first such rover were to travel nowhere near the Apollo 11 landing site, for example, what degree of protection could be offered to those historic first footprints from subsequent rovers and, eventually, actual tourists?

5. Space ethics by example

As the previous section implies, an understanding of the need for and breadth of an ethical code should be based on the consideration of practical examples, in effect ‘what we should and shouldn’t do’. A few example questions, in no particular order of importance, indicate the potential breadth of the discussion:

- Should we allow adventure tourism in low-Earth orbit, or will this eventually lead to an increase in orbital debris (e.g. from launch vehicle upper stages, abandoned accommodation modules and carelessly ejected trash containers)?
- Should we allow tourists to visit the Moon, or will this lead to the pollution of a pristine environment and damage to historic lunar landing sites?
- Should we allow the construction of orbiting advertisements visible from Earth, which would hamper astronomical observations?
- Should we allow scientists to land, and sometimes crash, their spacecraft on the surfaces of planetary bodies without initiating a regulated spacecraft decontamination programme (e.g. the intentional impact of Lunar Prospector onto the Moon’s south pole in 1999)?
- Should we allow the terraforming of Mars without first assuring that no indigenous, even dormant, life forms exist?

Having asked these and other questions, it seems obvious that they deserve answers. But who is asking these questions and who is answering them? At the moment, consideration is confined to a small body of concerned space professionals who consider it their duty
to do so. However, despite its best intentions, any such group risks preaching to the converted.

An attempt to expand the constituency was made in 1999, when protection of the space environment was the subject of an IAA/IISL Scientific-Legal Round Table at the 50th International Astronautical Congress. The content of the discussion ranged from scientific and technical to legal and ethical, and some interesting papers were produced [3–8], but the constituency for the subject remains small. The importance of promulgating these ideas, and of formulating policy, was addressed in a session at the second World Space Congress in October 2002 [9], and the process continues.

Certainly, if a set of ethics is to be developed for space, it is important that the majority of the ‘space community’, or ‘space profession’, is intimately involved. If, through ignorance or lack of interest, it is not, the profession risks having the job done for it, for example by politicians and members of the general public, who for their own reasons may wish to place restrictions on space development, or ban it altogether.

The risk of not adopting a proactive stance is illustrated by the fate of the terrestrial nuclear power industry, which has been wounded—perhaps fatally—by a combination of scientific ignorance among the general public, effective campaigning by anti-nuclear groups and bad publicity surrounding nuclear accidents. The ‘nuclear profession’, which includes scientists, engineers and policy makers, has done too little, too late, to counter the rhetoric of the anti-nuclear lobby, with the result that ‘nuclear’ is now widely considered a dirty word. In fact, the word is now so ‘politically incorrect’ that the medical profession has all but ceased referring to its NMR body scanners as nuclear magnetic resonance devices, preferring the sanitised ‘magnetic resonance scanner’ instead.

The ramifications of anti-nuclear campaigning within the space industry have also been significant. Research into nuclear-powered rockets (e.g. NERVA) was curtailed decades ago and, more recently, anti-nuclear activists in the USA forced a moratorium on the use of radioisotope thermoelectric generators (RTGs) in planetary spacecraft. Although there are now signs that NASA is willing to resist this and restart work on RTGs, the freedom to explore the solar system beyond the orbit of Mars has already been compromised, and could be once again.

This example shows that an ethical policy must work both ways. A policy of space ethics must not only protect the space environment, but must also protect the rights of those who wish to explore and develop it. A balance must be struck.

Thus an ethical code or policy for space should include guidelines for the exploration and development of the space environment and the protection of that environment for future generations.

Points of consideration should, among others, include the following:

- protection of Earth orbits (including LEO, MEO and GEO) as a commercial and scientific resource by formalising debris mitigation measures;
- protection of planetary surfaces (and those of smaller planetary bodies) to preserve their environments for future scientific study;
- protection of planetary surfaces to preserve possible indigenous life forms;
- protection of historic exploration sites on the Moon and other planetary bodies;
- protection of geological formations and other natural features of planetary surfaces for the enjoyment and edification of future generations (the ‘national park’ philosophy).

6. Formulating policy

The first step towards the formulation and agreement of a policy is the formation of an international consultative body to consider the relevant issues and raise awareness of the subject among space professionals and practitioners [10]. The question is, of course, under whose auspices should this body be inaugurated? Obviously, given the increasingly international nature of space exploration and development, it is important for the body to be as international as possible, ideally including representatives from all major spacefaring nations.

One suggestion would be to organise the body under the auspices of the UN, possibly affiliated with the United Nations Committee for the Peaceful Uses of Outer Space (UNCOPUOS), which has already taken an interest in space debris. An alternative might be the formation of a working group under the joint auspices of the International Academy of Astronautics (IAA) and the Committee on Space Research (COSPAR), while a third option might be a space agency/space industry forum. The pros and cons of these and other options may have to be discussed at some length before a decision is made.

In fact, several space agencies have already engaged in the debate. The European Space Agency’s contribution, for example, was led by a team from UNESCO’s World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) headed by Professor Alain Pompidou, the report of which was published in July 2000 [11]. Although, according to the report’s conclusion, it represented only “a preliminary phase”, it provided a good foundation on which to build.

The challenge now is to build on that foundation in an effective and pragmatic manner. For example, a common-sense approach that addresses the basics of
an ethical policy first is preferable to one which takes a fine-detail approach on a number of confined, special-interest issues. It would be advisable, therefore, to seek international agreement on a number of basic issues before producing a complex set of guidelines or policies to which only a few nations would be willing to sign up.

One needs only to look at the body of space law to realise that well-meaning work on behalf of the international space community is not always appreciated. For example, only a handful of nations have ratified one of the key pieces of space-related legislation, the Moon Treaty ("Agreement Governing the Activities of States on the Moon and Other Celestial Bodies", adopted by the United Nations General Assembly on 5 December 1979).

Another example is the International Telecommunication Union (ITU), which aims to coordinate the use of the radio frequency spectrum and geostationary orbital positions, among other things, to avoid harmful interference. Although, in most cases, this works well—since an interferer will generally also suffer interference—the ITU can only make recommendations and has no legal powers of enforcement.

Any future 'International Space Protection Union' may have to function under the same restrictions. The key to success will be to get as many parties with vested interests 'on side' as soon as possible. Thus, to represent the science community, one might seek to gain backing from major space agencies, such as NASA, ESA and the future combined Japanese space agency. To represent industry, one might seek the support of national space industry associations or, better still, the leading prime contractors themselves. However, to make the organisation as democratic as possible and to allow a broad-based 'ownership' of the ideas, issues and eventual policies, one would have to accept representations from a much wider field.

This is important because we appear to be on the cusp of a true commercialisation of space: witness in-space burials, tourists on the International Space Station and plans to send teleoperated 'theme-park' rovers to the Moon. There is no point in formulating policies to which only a few nations would be willing to sign up.

7. First small steps

Experience regarding the Moon Treaty and the ITU suggests that the formulation of any policy—ethical or otherwise—which seeks to control the use of space will be difficult. Nevertheless, it is too early in the process to declare defeat. Despite the limitations of current space law and policies—and however little they have been tested in the hostile environment of space commerce—space exploration and development has continued unabated for the past 45 years and shows little sign of ceasing.

So, assuming the formation of an international consultative body goes to plan, what should it do? The first small steps should surely include the following:

- formation and enactment of a policy to maintain and expand the constituency of the body, specifically regarding its international nature;
- formation and enactment of a policy to obtain funding and other support from key space-related organisations;
- formation and enactment of a policy to ensure the promulgation of ideas among the space community and the media;
- consideration of a 'set of guidelines' or 'code of practice' as a precursor to more formal policies or legislation.

Although the last point is the raison d'être for the body, the preceding points are also important. Their significance can be illustrated by considering the ramifications of their omission:

- if the body is not international in nature it will be considered by those outside as partisan and, however well-meant its eventual policies, they will be ignored;
if the body cannot secure at least some regular funding, it will be unable to operate a secretariat or provide expenses to those members unable fund their activities in support of the body;
• if the body does not appoint an experienced promulgator—a press and public relations officer, for example—the ideas and issues considered by it will remain ‘in-house’, much as they are today.

In the final analysis, although it is useful to draw analogies with terrestrial codes of ethics, and to learn from their successes and failures, space demands a somewhat different philosophy, based on detailed knowledge of the space environment. Various aspects of this philosophy have had to be adopted by engineers, programme managers and policy makers to enable mankind to explore space in the first place. Other aspects have been adopted by the people who have actually lived and worked in the space environment. It should come as no surprise that those engaged in discussions of space ethics will also be obliged to adopt that philosophy.

8. Conclusions

Discussions of ethical issues arising from space activities can be very broad and far-reaching—in both space and time—but such discussions are little more than a way to pass the time if they remain philosophical and academic. For such discussions to be of any practical use, they must be targeted towards the design of an ethical code or policy.

Despite the difficulties, the design of and agreement on a code of space ethics is considered sufficiently important to pursue. In practice, agreement on an ethical code for space may prove as difficult as agreement in space law, a topic that has been under serious discussion since the beginning of the Space Age. Nevertheless, an effort must be made now, before more serious and irreparable damage is done to the space environment.

The danger inherent in not developing an ethical code for space, or of not including protection of the space environment as a part of its foundation, has already been demonstrated by the former laissez faire attitude towards the terrestrial environment, which has led to the destruction of parts of that environment.

Although mankind may be decades from a return to the Moon, and centuries from terraforming Mars, the next half-century of space exploration and development is as difficult to predict as the first was in 1957, when Sputnik 1 opened the Space Age. Had an ethical code for space been in force in the late 1950s, much of the damage to the space environment might not have occurred in the decades that followed. Given the potential for development and exploitation of the space environment in the coming decades, there can be no advantage in further delay.

References