Space Science, Philosophy, and Policy

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IMPACT OF SPACE ON SOCIETY

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In his January 14, 2004 speech on the future of space exploration, President George W. Bush proposed a return to the Moon followed by “human missions to Mars and to worlds beyond.” Bush’s proposal, calling for both robotic missions and new manned space vehicles to replace space shuttles, sought a new justification for space exploration. In the words of then NASA Administrator Sean O’Keefe, this plan is not “merely for the sake of adventure, however exciting that might be, but seeks answers to profound scientific and philosophic questions.”[1] Such a justification for exploration suggests that today’s questions require interdisciplinary approaches to knowledge, and that the term ‘interdisciplinary’ encompasses not only integration across the sciences, but also consideration of the philosophical and cultural aspects of scientific research.

We propose that the philosophical and cultural aspects of solar system exploration be one of the core interdisciplinary research focus areas of space exploration. Specifically, we propose that NASA and ESA establish separate lines of funding to support interdisciplinary collaborations among scientists, philosophers, artists, writers, and public policy researchers.

Space exploration requires a broad range of interdisciplinary lines of scientific inquiry, from understanding the geological and climatic histories of other planets, to preparing for a sustained human presence throughout the solar system. Such research topics raise two types of questions, one set scientific and technical, the second ethical, cultural, and philosophical. US Public science agencies have increasingly viewed these two types of questions as complementary in nature. For example, in 1997 the US National Science Foundation changed its merit review criteria to emphasize the ‘broader impacts’ of proposed research in addition to its first criterion of ‘intellectual merit.’ Similarly, the US Human Genome Project and the National Nanotechnology Initiative each devote 3% of their budget to research on the Ethical, Legal, and

[1] Frontpiece, *The Vision for Space Exploration: February 2004*. National Aeronautics and Space Administration.

Societal Implications (ELSI) of their work. Such investigations provide a larger context for the science research being conducted, completing the cycle of knowledge by connecting research to the concerns of the citizens that fund this work. In an increasingly tight budgetary climate such justification is the surest means for ensuring that space research retains the attention that it deserves in the long term.

There is also precedent for this approach within NASA. For instance, some of the research within the NASA Astrobiology Institute (NAI) has considered philosophical issues. The Center for Astrobiology at the University of Colorado includes philosophical and societal issues in astrobiology as one of its research themes. This research, however, has been focused on fairly narrow epistemological issues such as the difference between historical and experimental sciences.

The intellectuals that articulate the needs, concerns, goals and dreams of humanity are typically not scientists and engineers – they are the writers, philosophers and policy makers who reach out and try to touch the hearts and souls of the men and women of the world. Including them in a dialogue with scientists and engineers that do the fundamental work of space exploration is an important strategy in understanding the long term viability of NASA's plans and vision.

Questions that a separate line of funding could explore include:

- How do individual space research projects speak to the reasons for why we explore? Scientists should be encouraged to reflect on the larger goals and consequences of their anticipated scientific results.
- One goal for space exploration is to explore the solar system for scientific purposes and to support human exploration in order ultimately to establish a sustained "presence" throughout

the solar system. What are the ethics of developing a sustained presence on other worlds? What about the ethical issues of resource acquisition outside our own world? Might there be a legitimate concern that the spirit of exploration can mean avoiding dealing with the essential finitude of the Earth and its resources?

- Should we send poets and philosophers, artists and architects to space along with pilots and scientists? Who shall we designate to reflect on the meaning of exploration, derived from direct experience in space, and communicate this to the general public?

To address these questions, Southwest Research Institute's Department of Space Studies in Boulder, Colorado is creating a Center for Space Science and Culture to focus on the ethical, philosophical, and cultural aspects of solar system exploration. The purpose of this Center is to draw more consciously upon the expertise of scholars trained in the areas of art, philosophy, and religion in the design of our space policy. Take the example of the space station. We have missed an opportunity by not treating the space station as a *humanities* laboratory as well as a science lab. Bringing scholars in history, politics, philosophy, art, music, literature and religion to the space station would expose them directly to the experience of space travel. Moreover, space inhabitation could inspire their thinking upon crucial issues such as the changing place of humanity in the universe, the implications of our growing understanding of the cosmos, and our increased appreciation of the interdependence of life on earth.

We must, to be clear, draw a distinction between policy *advocacy* and policy *research.* The purpose of advocacy is to narrow political choice to preferred ones. Policy research, on the other hand, seeks to widen the set of choices presented to policymakers by investigating the consequences, risks and perceptions of different courses of actions. In order to secure and retain respect for the independence of its research, the Center will engage only in policy research.

The immediate goals of this study center are twofold:

1. Convene a multidisciplinary workshop on space policy, ethics, history, literature and art in August of 2005. Participants will contribute scholarly chapters to a peer-reviewed edited book to be published in 2006.

2. Obtain multiple independent funding streams to sustain the activities of the Center on space science ethics and policy.

The Center will also investigate the burgeoning private space tourism industry and its impacts on the space business and public opinions on space. The prospects for using resources on other worlds, such as ice at the lunar poles or subsurface liquid water on Mars will be assessed, and their economic and political implications examined. The level of multidisciplinary interaction expected between scientists, ethicists and other scholars with the Center will mean that an ever-wider range of topics will be addressed as the Center evolves.

Initially, the Center will focus on seven themes: The Space Market, Ethics and Values in Space Exploration, Public Perceptions of Space, Space Science Missions and Funding, Planetary Protection, Why Space?, and Human Choice and the Humanities. For instance, ethical issues with respect to space exploration are increasingly in the public consciousness. A recent example that has, legitimately or not, been thrust into the public awareness was the launch of the Cassini spacecraft to Saturn in 1997. The spacecraft had on board 72 kg of radioactive and highly toxic plutonium to power its thermoelectric generators. Reactions to the danger of launching this material atop a rocket ranged from public hysteria to extreme condescension by some NASA managers. Those concerned with the dangers pointed out that since 1 microgram of plutonium is sufficiently toxic to kill a person, 72 kg is sufficient to kill every human on the planet 6 times over. While this is statistically true, it neglects the dispersion of material should an accident occur, and the massive and creative efforts to launch this fuel safely, including encapsulation in hard iridium shells. Modeling efforts of the worst-case scenarios by scientists showed that even if the rocket exploded, the iridium shells (or at least most of them) would not break open, and plutonium contamination was an extremely unlikely outcome, even if the launch vehicle exploded.

Yet, even if it were possible to quantify the risk associated with launching plutonium into space, such an assessment would be largely irrelevant. Much of the protest centered on the apparent arrogance of scientists risking the lives of people for what is purely scientific self interest. Or perhaps worse, the apparent arrogance and influence of the aerospace industry to carry on how they see fit, regardless of public opinion or the perception of immoral behavior (endangering the lives of people).

Regardless of the perception or reality of risk, however, the launching of radioactive materials into space (for the purpose of exploration) is very clearly an ethical issue. Launching nuclear *reactors* into space for power and/or propulsion, the goals of Project Prometheus, is both an ethics issue and in violation of nuclear proliferation treaties. Not to expect a strong call for public debate on the ethics of nuclear devices in space is naïve. Indeed, if we are to take the stewardship of our planet seriously, we must undertake a vigorous discussion of all the ramifications of sending nuclear devices into space. This dialog should not, of course, take place only between scientists.

Ethicists, writers, journalists and others must weigh in with scientists to understand why and how we value space exploration. How committed is our society to spending public funds in space and to making specific accomplishments? What costs and risks might be acceptable, and why? How do we place value on risks associated with the potential radioactive contamination of different regions of the Earth, or the perceived global threat due to military space control, or the possibility of the contamination of other worlds?

Human reason seeks knowledge not only of our environs and the physical laws at play, but it also seeks self-knowledge. The implications of a particular technology, or of a course of action such as exploring the frontier of space, are written not just in the science, but in the textural changes they make to the lives of human beings. It is in this sense that philosophers, writers, and policy makers should be included in the grand human adventure of exploring the solar system. It is our purpose at the Center of Space Science and Culture to reflect on how space science and technology have and will alter our relationship with the universe and between ourselves.

End

Public Perceptions of Space

Public perceptions of space, space exploration, and human spaceflight are heavily shaped by the media, film, and science fiction. Cinematography and computer animation are so sophisticated today that realistic simulations of what it might be like to be 'out there' are common. A drama played out on an isolated Martian outpost, for example, may stimulate a sense of our human destiny and our future in the cosmos. Artists and writers can show us imagined futures, within which values, ethics and outcomes are investigated. In this sense, the larger-than-life promise of space in popular culture spawns both public enthusiasm and deeper insight into the societal issues that may become important as we explore space.

However, there is evidence that the hyper-real world of science fiction has blurred the distinction in many people's minds between what has been accomplished in space and what is fiction. For example, polls show that about half of Unites States citizens believe that aliens have visited the Earth. Surveys of student attitudes about space reveal that many think humans have already been to Mars, or that the Apollo moon landings were an elaborate hoax. Television shows such as Star Trek and the Star Wars movies make us comfortable with images of space, even fantastic ones, blurring the distinction in public attitudes between what is possible and what has actually been done in space. Such gross misperceptions result not just from a lack of science education, but from a deeper malaise rooted in our relationship with technology and knowledge.

Clearly, public perception, whether accurate or wildly uneducated, is the ultimate source of continuing support for NASA's exploration of the solar system. Scientists who present the latest images and ideas from the exploration of the Universe regularly to school children see first hand the way our field spark awe and understanding. Black holes, Martian river valleys, and the rings of Saturn are guaranteed to excite and inspire school children. Adults are awed by these things, too, and share in the wonder of the Universe and pride in their country for these incredible technological achievements.

On the other hand, NASA has been heavily criticized for huge budget overruns, the International Space Station runs on a skeleton crew of two, and NASA's only ride into space is dangerous. Public criticism of how NASA has set its priorities and spent public funds since the Apollo days is substantial. Promising missions have been curtailed or cancelled, people have died in space, and robotic spacecraft have been lost. While the public shares the glory of space achievements, there has also been uneasiness about the ambiguity of NASA's mission.

An important component of this project is to research the links between public support for space exploration, education, and the political processes that enable space missions and science.

Space Science Missions and Funding

Public support for science funding necessarily waxes and wanes over time, as does the funding itself. The causes of variability in public support and in the funding picture for science are often not the same, and may or may not be related (Sarewitz 1996). The general trend of science funding is well-known: steady, steep growth since World War II. The political structure for post-war science was assembled with the impetus of Vannevar Bush's report to the President of the United States, *Science the Endless Frontier*, in 1945 (Bush 1945).

The fundamental postulates of Bush's report were that the promise of science and technology are limitless, and that the return on investment from fundamental scientific research is indeterminate, but potentially similarly limitless. Indeed, the current military, technological and economic power of the United States is strong testimony for the vision of *Science the Endless Frontier*. Enthusiastic political support for the massive Apollo project was rooted not only in a space race to project national power, but also in the creed that unfettered research funds are a necessary condition for scientific and technological greatness.

Among all science enterprises in the US today, space science probably benefits most from the cold war-national pride dynamics that powered the post war rise of science. Space missions, both manned and robotic, also enjoy strong support from the U.S. public. Logsdon has argued that the real source of support in NASA's exploration programs is national pride (Logsdon 2004).

The exact nature of public support for the US space program is difficult to gauge in a population where more than half its citizens believe that aliens have landed and walked among us (Jakosky 1998). Certainly, the frontier aspects of space exploration and eventual colonization of other worlds resonate deeply with many Americans (Zubrin 1997). Mastery over space is most likely seen by most Americans as its country's destiny, and is a largely unquestioned long term goal of the U.S. military (Logsdon 2002). Although NASA's budget is currently at an all-term low in terms of its percentage of the U.S. Federal Budget (0.6% in FY 2004), it is currently sustaining the International Space Station and is readying to launch a refitted, safer Space Shuttle. It has two highly capable rovers scouring the surface of Mars for signs of water, and along with two powerful spacecraft in orbit, is deluging the public with the beauty and wonder of this alien world. Due to NASA's enormously successful Mars Program, scientific understanding of that planet is increasing by leaps and bounds. NASA has the most powerful robotic spacecraft ever built in orbit around Saturn, daily returning images of breathtaking beauty and other data of immense scientific value. The Huygens lander, European-built with U.S. cameras, landed on Saturn's extraordinary moon Titan, and has returned spectacular images of a truly alien world -- one made of ice, not rocks. At -450 F, ice is rock, and when heated inside the ice volcanoes of Titan, becomes a slush-magma. Organic particles float down from the upper atmosphere to settle on the ice rocks, and the foggy landscape is covered with ghostly swatches of small hydrocarbon micro clouds. Sample and return missions are in full swing, with solar wind particles collected and returned to Earth, and cometary material to be returned in 2007. Missions are on their way to Mercury and to comets. One will bombard a comet with a 500 lb copper projectile moving at 17,000 miles per hour, creating an artificial impact crater. Soon, a mission to Pluto will be launched, and a sample returned from the Moon's far side. NASA's constellation of Earth monitoring satellites are providing a global picture of weather, geologic processes, resource locations, land-use changes, and climate and ocean changes. Many other spacecraft missions are also flying, investigating the Sun, space weather, planets around other stars, general relativity, and the nature and beginning of our Universe. Making sense of the immense diversity of missions and their data is well supported by NASA's Research and Analysis (R&A) programs. Through competed grants to individual scientists within academia, industry and non-profit research institutions, fundamental research is driven by the great wealth of new spacecraft data. These NASA programs ensure that high-quality, peer reviewed research on the nature of space and our potential role in it is published in the scientific literature. Because of the powerful public response to images from space and to a deepening understanding of the cosmos, scientists are also heavily engaged with the public via a wide range of media. In the era of the Internet, the scientific discoveries and their discussion and analysis (covering a wide range of styles, from scholarly to those for the educated public, to K-12 audiences) are acquired nearly instantaneously. There is no doubt that the mysterious, wondrous discoveries of our world other worlds as revealed by NASA's missions woven into the fabric of our technological lives.

The exploration of space, while exciting and revolutionary, is by nature a luxury paid for by our society. Each year NASA's budget is set by the Congress (after input from the President) within the Veteran's Administration-Housing and Urban Development appropriations. It must then be approved by the entire Congress and finally authorized. The complexity of governmental negotiations with respect to spending is legend. Advice on scientific priorities is routinely collected by special commissions authorized by the President, or by the Space Studies Board of the National Academy of Science. This kind of advice, while necessary and valuable, represents only one input to the decision-making process. Fiscal realities (such as the present-day deficit spending), compromises with other pieces of legislation, legislative ear-marks and a huge variety of other pressures also play extremely central roles in deciding ultimately how much money will be in NASA's budget from year to year.

Planetary Protection

Planetary protection falls into two areas:

1. Protecting the Earth from natural disasters caused by infalling asteroids and comets,
2. Ensuring that our spacecraft do not contaminate other worlds, or bring pathogens back to Earth.

Significant work by SwRI scientists has been done on the nature of the threat due to an asteroid or comet impact on the Earth (Chapman and Morrison 1994). SpaceWatch is a vigorous program to observe and catalog all potentially dangerous impactors over 100 m in diameter in the vicinity of the Earth. Discussion on mitigation strategies have ranged from blowing asteroids up with nuclear-tipped missiles, to attaching solar sails so that they gently swing away. Since current and future missions to asteroids and comets have greatly improved our knowledge of these objects, a serious discussion of the merits, risks, ethics and costs of mitigation strategies is demanded.

The second form of planetary protection, contamination, is an important ethical and psychological issue in today's society. To some, sending craft that may contain our microbes to unknown worlds is akin to the infamous genocides of spreading populations in human history. Yet quantitative analyses have been done on this issue, and NASA has developed detailed protocols, for sterilizing interplanetary spacecraft. How does one argue that a scientific definition of 'good enough' has any relevance to someone who argues from a position of reverence for life? Science, in general, needs to be sensitive to views that may not be supported rationally, but may be deeply held. It is here where humanists and scientists can work together to understand how values in science may not translate to values in the public.

A more complex contamination issue has to do with 'back contamination', that is, bringing unknown microbes from other planets to Earth. Michael Crichton's famous book *Andromeda Strain* depicts the devastation wreaked on Earth from a virus brought back from space. As extremely unlikely as this scenario is, science cannot make any credible guarantees that a Mars rock will not contain a devastating microbe. In this case, our hubris could mean massive suffering and death. Scientists can model the likelihood that there are microbes on Mars, that they would be pathogenic, that they would survive to Earth, and escape containment. But such measures are useless in convincing some people that a sample return is a worthy thing to do for society. This is especially true if they have strongly held beliefs that science is arrogant and unresponsive to society -- views that are not uncommon (Grinspoon 2004). How, in such in an environment, should scientists proceed, in order to convince society that the risk is worth taking? This dialog is not only about measurements and models; it is just as much about values and the role of science and technology in society.

Why space?

With the echoes of Kennedy's challenge to go to the moon still ringing in people's minds, Lyndon B. Johnson wrote: "The fate of our free society--and the human values it upholds--is inalterably tied to what happens in outer space, as humankind's ultimate dimension."

Human destiny. It is not only conceivable, but probable, that the human race will eventually leave Earth and colonize Mars. Ultimately, colonization means that the human race has begun to spread, achieving a kind of cosmic immortality. With this step comes Johnson's idealist dream -- that to immortalize the values of a free society, we must get to space and do it first.

It is difficult to take such ideas seriously, because they are so vast, perhaps impractical, and they take so long to bear fruit. But it is also difficult escape the realization that with each probe and lander, each orbiter mapping resources, each sample return, we are inevitably preparing ourselves for a deep understanding of the planets, deep enough to send expeditions and colonies there someday.

There are of course many other reasons a space enterprise exists. It gives aerospace companies high-profile, civil projects to work on, while developing space capabilities and technologies at a high rate. Mastery of space is a term used in Defense, and is considered a top priority for U.S. security and supremacy.

To the degree that these factors interact, it is worth exploring how national pride, a sense of human destiny, economics, or the strategic drive for military presence, shape the present process for establishing priorities in space science.

Human Choice and the Humanities

Everyday, we live and are surrounded by technology. This structure enables us to be extraordinarily productive and powerful. Technology is so intricately linked with our day-to-day life that it is the background for our existence. Most of our choices and priorities are made against this background.

At the same time, the technology we use is so complex that not one of us knows how it all works. Even less do we understand what technology does for a sense of fulfillment or for the prospects of leading a life of peace. Studies are being done in these areas, because the transformative effects of future technologies on society may be vast. It is clear that a comprehensive examination of how science and technology affect our lives, our choices, and our actual nature is imperative if we wish to see greater balance, freedom, and peace arise from our efforts.

For many scientific disciplines, the cause-and-effect relationship between scientific outcomes and the well being of people is of extreme importance. Simply put, scientific results and their technological progeny are the dominant forces shaping our world's future. What role science will play in determining the quality of life for every human being on the planet is, of course, determined by the elite that funds it. In this way, all of scientific enterprise is embedded in the greater moral problem of how individuals and groups should conduct themselves. Is it better for the powerful to channel their efforts solely for competitive self-benefit, or to distribute knowledge and technology among all people? What are the consequences of pushing technologies on societies that may not want them? For some fields, these issues spring immediately from contemplating the promise and implications of their projects. If we can choose the human qualities of a future person through genetic engineering, who is to decide what these will be, and to whose progeny they will go? Other subjects may be further afield, but the stunning conceptual shift forced on us by the quantum nature of the infinitesimal in the 1920's has led to by far the most transforming technology in history: electronics.