AIAA SPACE 2007 Conference & Exposition
18 - 20 September 2007, Long Beach, California

AIAA 2007-6069

Space and Perceptions of Space in Spacecraft: An Astrosociological Perspective

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[Abstract] The authors report on the concepts and issues underpinning what they term space-based information transfer systems (SBITS), that seek to connect global audiences through web interfaces with real-time images of lunar landscapes, video and displays monitoring a variety of astronaut activity from within the International Space Station, and other such schemes. The underlying assumption with such efforts is: If personal computer technology and applications have been commercializable, then their infrastructure and processes applied to space will be commercializable. However, many obstacles have emerged regarding the funding of such schemes, the actual scope of the technological infrastructure required to mount the systems, questions about intrusion on astronaut crews' privacy, confidentiality, personal space, and workload. Regardless of their current "doability" status, these schemes are a convergence of various sub-taxonomies of space: cyberspace, outer space, personal space, public space, and cultural space.

This report takes the astrosociological approach in examining the key issues concerning SBITS schemes. If resources were to emerge and the technology were to develop to enact SBITS schemes, spin-off benefits of casual outer space information transfer on Earth may have considerable social impact. Web link infrastructures aboard or near the International Space Station, or even further afield, could serve as interactive nexuses between astronauts and a diversity of persons on the Earth. The authors discuss a range of issues, including: Once a system is mounted and begins to be used, what methods might be employed to gauge the results of the usage of these systems? Since SBITS schemes are about sharing and distributing the human experience of space through a two-way – or perhaps multiple-way -- feedback system, it may positively impact the experience of life on Earth and serve to improve the vigor and sustainability of the space endeavor.

Keywords: space-based information transfer systems (SBITS), microsatellites, nanosatellites, robotics, planetary consciousness, planetary situation awareness, 1International Space Station, sustainability

I. Introduction – The Authors' History of Ideas

WHAT a scientific adventure it was for author Dudley-Flores to ask for near real-time satellite imagery and get it for her studies of Arctic coastal processes, ice morphology, and palaeostream channeling! As a researcher at the University of Alaska's Geophysical Institute in Fairbanks, she had access to Landsat Multispectral Scanner (MSS) Quick-Look services. She was able to view planetary phenomena in the color infrared from the perspective of an orbital altitude of 917 km. The Landsats were supplanted through the 1990s by other more capable space imaging platforms, and Dudley-Flores left the planetary sciences to pursue the social sciences. And, in considering social problems, large and small, that often connect to aspects of the physical environment, she wondered if solutions could be more readily discerned if more of a global audience could view the Earth from the vantage point of space. But, access to space-based systems, until the advent of the Internet, were largely reserved for those who could connect to scientific facilities. And, then, one might be hampered in what one was looking for because so

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much satellite imagery is classified and not available to ordinary civilian researchers. That situation still obtains in our current "Google Earth" era.

With the maturity of the Internet, enterprising and creative computer applications entrepreneurs began to consider the issue of how to merge outer space production with cyberspace production, which would, by necessity, require a synthesis of the Internet and space-based platforms. The latter would include platforms that might not be regarded traditionally as satellites. Observing this, the authors were quite excited by this development. Might these entrepreneurs, some who had made tidy fortunes in pioneering Internet industries, become force multipliers of the space endeavor? One of the more successful has been SpaceDev, headquartered in Poway, California, that became more action than talk when it built and operated the Low Earth Orbit (LEO) microsatellite, the Cosmic Hot Interstellar Plasma Spectrometer (CHIPSat) in January 2003. CHIPSat is the first American satellite to use TCP/IP[‡] for end-to-end satellite operations control. The satellite was built for the University of California-Berkeley under NASA's University Explorer Program (UNEX).[§] SpaceDev's founder, James. W. Benson, who entered the aerospace contractor industry from the computer applications industry, is now involved with the issue of developing space tourism and civilian spaceships. However, not long after the founding of SpaceDev, Benson had been interested in a space-based information transfer system (SBITS) scheme that would allow Internet users to view real-time landscapes from lunar orbit and later view real-time terrain from cameras mounted on lunar rovers (1999).[**] Interested in the challenges that SpaceDev found in developing this project, the authors and several colleagues made a pitch to Dentsu Corporation of Japan over 1999-2000 (2000).[1] Interestingly, in 2001, Dentsu shot Japan's first space commercial aboard the International Space Station (ISS) in the Russian module using a high-definition television camera and tapes provided by the National Space Development Agency (NASDA)[††]. After that, we heard no more about Dentsu's interest in the lunar webserver project. No "Thank you, for letting us review your proposal." Nothing.

With the development of AERCam[‡‡] (Fig. 1) and Mini AERCam robotics from the mid-to-late 1990s, other technological opportunities emerged. Developed under NASA's Johnson Space Center Directorate, AERCam technology is characterized as a free-flying robotic inspection vehicle. Its "Mini" version is also classed as a nanosatellite. Weighing in at 10 lb and with a 7.5-inch diameter, NASA's factory specs on the smaller version of the flight-tested article are as follows below.[§§]

Figure 1. To right, the AERCam

Source. http://aercam.jsc.nasa.gov/index.htm

> Mini AERCam hosts a full suite of miniaturized avionics, instrumentation, communications, navigation, video, power, and propulsion subsystems, including two video imagers and one higher resolution still-frame imager. Technology innovations include a rechargeable xenon gas propulsion, rechargeable lithium ion battery, custom avionics based on the PowerPC 740 microprocessor, "camera-on-a-chip" CMOS imagers with wavelet video compression, micro electromechanical system (MEMS) gyros, GPS relative navigation, digital radio frequency communications, micropatch antennas, digital instrumentation network, and compact mechanical packaging.

By 2004, European entrepreneurs began conceptualizing about space-based links to the Internet to communicate video and other types of electronic monitoring of astronauts aboard the ISS. Dudley-Flores, who was familiar with the Mini AERCam from participation in the American Institute of Aeronautics and Astronautics, determined that the European platforms could benefit by using Mini AERCam robotics. However, when author Dudley-Flores and fellow American aerospace architect colleague, Constance Adams, made inquiries, it was clear that European conceptualizers did not understand the capacities and

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[‡] Transmission Control Protocol (TCP) and the Internet Protocol (IP)
[§] http://en.wikipedia.org/wiki/SpaceDev
[**] Personal communication.
[††] http://www.spaceandtech.com/digest/flash2001/flash2001-092.shtml
[‡‡] Autonomous Extravehicular Robotic Camera
[§§] http://aercam.jsc.nasa.gov/Mini-AERCam_extended.htm

limitations of the platform (2005).[***] Shortly thereafter, author Jun Okushi was brought into the discussion. Through these discussions, we pondered the "what ifs." What if engineers and designers could ramp up the capacities of Mini AERCam robotic nanosatellites and post them in and around the ISS? What if the platform could be linked to a network of satellites that would connect the feed from the Mini AERCams to the Internet user? If this were doable, then some interesting possibilities, as well as research opportunities, would emerge. Because of the possibilities, the design process would, by necessity, have to deploy human and social factors engineering and a state-of-the-art communications system for interfacing with diverse cultural others on Earth.

Would communicating the experience of astronauts aboard the ISS transcend cultural, technological and interdisciplinary divisions on Earth? Would a multi-modal communications system inspire a new human cognition by enabling comprehensive human perceptions of space, humanity's places within it, and cultural identities in relation to one another by offering a diversity of human percipients' intimate experiences from the Cosmos-based vantage point? After all, astronauts have returned from space missions claiming to have been changed from their unique vantage point of being "up there."

II. Planetary Consciousness

The significance of this vantage point cannot be understated. In 1950, astronomer Sir Fred Hoyle wrote the following prediction for a BBC radio broadcast, "Once a photograph of the Earth, taken from outside is available – once the sheer isolation of the Earth becomes known – a new idea as powerful as any in history will be let loose."[2] That photograph was the one that became known as "Earthrise" (see Fig. 2). Another of the most famous images returned from space was one labeled "African Continent, Blue Marble (see Fig. 3). Albert Gore used both of these images in his feature-length documentary, *An Inconvenient Truth,* to demonstrate both the fragility of the Earth and the interconnectedness of things in the world in the face of global warming.

Figure 2. Earthrise. Taken from the Command Module on July 20, 1969, the *Apollo 11* astronauts do not recall which one of them took this memorable photograph. The lunar terrain is shown, centered at 85 degrees east longitude and 3 degrees north latitude on the nearside of the Moon in the area of Smyth's Sea.

Source. NASA photo ID AS11-44-6552

Figure 3. African Continent, Blue Marble. This view of the Earth was captured by the *Apollo 17* crew on the way to the Moon on December 7, 1972. This was the first time an Apollo trajectory allowed for an image of the south polar ice cap.

Source. NASA photo ID AS17-148-22727

[***] Personal communication.

In 1971, on the Moon and on the way back, Astronaut Edgar Mitchell experienced an incredible alteration in human perspective that he describes as "life-changing" in his book *The Way of the Explorer*.[3] Out of the window of the *Apollo 14* Command Module, he contemplated his:

> blue jewel-like home planet suspended in the velvety blackness from which we had come. What I saw out the window was all I had ever known, all I have ever loved and hated, longed for, all that I once thought had ever been and ever would be. It was there suspended in the cosmos on that fragile little sphere. I experienced a grand epiphany accompanied by exhilaration, an event I would later refer to in terms that could not be more foreign to my upbringing in West Texas and later, New Mexico. From that moment on, my life was irrevocably altered.

Thomas Gangale has written that the most important thing we discovered on the Moon was a part of ourselves "In the few hours that a few of us spent on the Moon from 1969 to 1972, we became better earthlings. As the poet Archibald MacLeish wrote, we were 'riders on the Earth together.' We realized that we were our brother's keeper, and we remembered God had appointed us stewards of the Earth (2005, p. 127)."[4] Author Frank White discussed at length this type of epiphanic experience in space and from imagery from space in his book, *The Overview Effect: Space Exploration and Human* Evolution.[5] White described this phenomenon as:

> A complex and profound meta-experience that astronauts and cosmonauts have reported that runs the gamut from a type of spiritual experience to a realization that we humans, as separated as we are by all manner of boundaries, are, in the final analysis, the progeny of one precious world with a thin veneer of atmosphere.

This unique perspective is shared by just over 400 human beings. As such, a problem currently exists. The global public has never seen "the big picture."

III. The Problem of Planetary Consciousness and Potential Solutions

The average human being has not experienced the view from space on a personal basis, although these pictures from space have been around for upwards to 40 years. Subsequent years have brought more space missions, both human and robotic, with fabulous imagery. Robotically, we have stood on the ground on Mars, we have seen up close mighty impacts on Jupiter, the rings of Saturn, and towering dune fields on Titan. We have even seen the great columns of hydrogen clouds spanning light years that are the incubation places of stars and looked back in time toward the very birth of the Cosmos. Why haven't the peoples of the Earth been subsumed by this overwhelming experience of viewing things in space and the world from the space? Why haven't they beaten their swords into plow shares, held hands and sang *Kum Bah Yah,* and turned their attention to turning the tide against global warming, a fairly immediate threat as time is kept over generations that can kill more people than all of the wars of the Earth put together?

A. Searching for Answers

A clue to this enigma lies in a prediction that failed to come true that was made by Sir Arthur C. Clarke in his novel *2061: Odyssey 3* (1987, p. 4).[6] In the story, the Earth had become relatively peaceful once everyone had access to free long-distance telephone calling service. With the Internet and the quality of communications technology today, we *can* make free long-distance telephone calls. At least those of us who can access, can operate, and can afford the technology can make those calls. One can be in London and make a phone call to someone in Peshawar and the other party sounds like he is speaking from the next room. But, there are still wars, India and Pakistan might yet fight a limited nuclear exchange, and the large part of Earth's population hasn't yet caught on to the impending devastation of global warming. What is the problem? The answer to that has to do with the inadequacy of the delivery systems of these images from space and to the fact that studies of how humans comprehend spatial and other types of relationships on the ground, in space, and across cultures are still in the infancy of synthesis and application.[†††] Lack of political will is another problem. In *An Inconvenient Truth,* both the documentary and the

[†††] Many in-depth studies exist of human perceptual abilities, of systems of kinship across cultures, of various types of cultural differences, and a wide array of social and behavioral phenomena, but little has yet been done to synthesize among these studies along the lines of the unifying schema of the natural sciences, particularly among the physical sciences. It may take the natural sciences to facilitate and legitimate this type of synthesis among social and

book,[7] Albert Gore also spoke of the "backburner" attitude that his American congressional colleagues demonstrated when he gave them slide shows about global warming. The problems on the radar screens of congressional constituents were more immediate so their representatives did not move to act to hammer out legislation to help offset the more overwhelming planetary issue. Sitting in the gravity well of the Earth, with some people being able to see pretty pictures from space, and with some people being able to talk to other people cheaply at a distance still hasn't communicated the *gravity* of our situation. The planetary situation awareness of the average person is poor. It isn't very real to most people that Earth is a planet in space, that it is in danger from global warming, and that seeing it from space helps us assess the condition of the planet and provides us with direction how to keep it livable.

A science fiction story by Ray Bradbury provides a clue to the solution. "The Rocket" tells the story of Fiorello Bodoni, a poor junk dealer, who uses his family's savings to build a replica rocket from an old mock-up and outfits it with virtual reality simulations to provide his children with the trip of a lifetime.[8] To communicate the isolation of the Earth in space, to emphasize our interconnectivity on this one world, and to impart to *any* human being his/her planetary situation awareness just in the way that an astronaut knows it requires that a diversity of people must be able to connect in an intimate way to the reality of the Earth as a planet in space.

Alas, we do not yet have the capacity to cheaply offer rides into space for millions of people to experience this reality. But, we do have the technology and knowledge to make the experience as *numinously* real as possible and to distribute it across a diversity of cultures in ways that it will be understood. The notion of numinosity comes from Rudolf Otto's book *The Idea of the Holy: An Inquiry Into the Non-Rational Factor in the Idea of the Divine and Its Relation to the Rational* (1923).[9] ‡‡‡ Numinosity seems to be related to the experience that many astronauts describe.

Let us suppose that our research question was "Why don't people have better planetary situation awareness?" Then, a hypothesis we might generate from that question would be: If every person on the planet could see the Earth from space and experience being in space, then each person could develop a planetary consciousness. In other words, if a diversity of people could experience the space experience as realistically as possible, then they would demonstrate heightened situation awareness. This situation awareness over time could then be measured by various indicators that would demonstrate a trend toward good global citizenship, social investment in people, and outward and future-looking optimistic views *vs.* nationalist agendas, unbounded profit-making at the expense of people and the planet, and a decrease in inward, past- and present-looking fatalistic views. Some indicators would be things like increased demands for laws to protect the environment, for better disaster preparedness on the parts of local, regional, and national governments, for educational programs pitched toward mitigating the planetary global warming emergency, and an overall greater interest in the long-duration human exploration and development of space and the future of humanity. This leads to the enunciation of a related hypothesis: Constructive holistic thought processes and actions can potentially become physically manifest on an individual, collective, and global scale if technology, human intelligence, and international cooperation are harnessed effectively cross-culturally and across disciplines.

B. The Future of Space-Based Information Transfer Systems

Can space-based information transfer systems (SBITS) develop in an ever-increasingly Internet-connected global audience a planetary consciousness? The authors think that it is likely. In terms of reaching large volumes of people, permutations of web-based SBITS encounters and virtual reality-actual imagery, audio, and other feed combinations have a better chance of instilling such a global group state within the next several years than the tiny growing cadre of space tourists and entrepreneur-astronauts in the same period of time. As Thomas Gangale has pointed out, in disabusing the computer applications technologist's space development expectations with astronautical fact, "…there is no astronautical analogue to Moore's Law (Dudley-Flores and Gangale 2007)."[10]

NASA appears to have recently come to understand the utility of a virtual reality-actual feed combination. The head of NASA-Ames Research Center, Simon "Pete" Worden, has partnered with Silicon Valley talent to produce an online 3-D virtual world called "Second Life." The game allows Internet-connected participants to create avatars of themselves in the virtual world. Worden told an audience at the National Space Society meeting in Dallas, Texas

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behavioral phenomena. Examples of such pioneering work are those studies that use state-of-the-art medical imaging to show brain region differences between Westerners and Asians in language use and mathematical calculations.

‡‡‡ The Lutheran theologian Rudolf Otto uses the word *numinous* to describe a personal experience of spiritual power. Otto borrowed from the ancient Latin, *numen,* usually translated as "the presence of a god or goddess," or more precisely, "the power or nod of a deity." For Otto, numinosity originated from outside the self, but was perceived within (http://web.ncf.ca/dy656/earthpages3/articles_numinosity.htm).

in May 2007 that "Real data from real missions such as the International Space Station can be ported into virtual environments." Worden described that by matching the attributes of cyberspace with small, inexpensive space probes using micro-satellite technologies, a new world of space exploration was feasible. He told his NSS audience that when the next people step on the Moon and expand into and settle the solar system that all could go along through their avatars in such games. "The revolution in nanotechnology means we can do pretty surprising things in very small packages," Worden said.[§§§]

It is a matter of time before these technologies mature, some faster than others, and a web-based system will distribute through diverse user interfaces across cultures the experience of space on Earth. This may be accomplished through games, mobile technologies and architecture, and educational interfaces. As these users view their Earth from space and become aware of their situation, the authors think it likely that they will want to address our most pressing contemporary global issues. These components can be expected to feed into a generative learning system that may impact the diversity of cultures and our well-being *in toto* as a planetary society that has crossed the threshold into a suite of overwhelming challenges.

IV. The Obstacles to Planetary Consciousness and the Astrosociology Connection

The issues related to functional and effective space-based information transfer systems (SBITS) involve social scientific concepts applied on a scale grander than merely the societal level. As astrosociology develops as the unifying single perspective in the social sciences to investigate space issues as they relate to humanity, this area of research and development may well become a major specialty area within the field. The significance of a planetary consciousness, a planetary situation awareness, from god-views of our home planet, of the Moon, and from "like being there" methods, is that we may expect them to improve the human condition.

However, there are many obstacles for SBITS systems and would-be users. Some are listed below.

- Availability of the technological infrastructure required for mounting the systems for a global audience
- Intrusions on astronaut crews' privacy, confidentiality, personal space, and workload
- Social, cultural, religious, and political barriers to user interfaces[****]
- A lack of (or lack of interest in) a unifying stock of knowledge about the linkages among the sub-taxonomies of space: cyberspace, outer space, personal space, public space, and cultural space[††††]

Astrosociologists are positioning themselves to study these obstacles and to report on their status as new projects and programs come online.

V. Conclusion

Establishment of a planetary situation awareness, which is what we mean by "planetary consciousness" in this report, may doubtless prove difficult to achieve due to the many obstacles outlined above and those we have not yet reckoned. We can witness the fact that all of the space missions of the past have inspired many people on a particular level, but such a level of inspiration is much less profound for ordinary people than the space elites (e.g., astronauts and cosmonauts) who actually experienced what it was like "up there."

Author Frank White has mentioned on the radio that he would like to allow more human beings to experience the "Overview Effect" by creating realistic simulations of space travel that go beyond the visual to include the other senses and perhaps create the feeling of isolation as sensed by space travelers. And, if the ordinary individual in Canada, in Italy, in Mozambique, in the Seychelles, in Tajikistan, in Mongolia, in Papua-New Guinea, and in California or any other locale, in his or her space-like isolation, can look out the window to apprehend the Earth, there will likely swell within his or her heart new feelings and new realizations. Such is a paradigm shift, born of humanity abroad in the Cosmos, even if bound to the Earth. This shift can be expected to more tightly integrate humans, their machines, and the experiences of all those on Mother Earth. By engaging the challenges of abyssal

[§§§] http://www.space.com/adastra/070526_isdc_second_life.html (by Leonard David).

[****] In the United States alone, there are widespread popular notions that the space endeavor has nothing to do with social problems that may prevent even educated, socially concerned individuals from using any SBIT system

[††††] However, a good launch point is the life's work of anthropologist Edward T. Hall as elucidated through his several publications (http://en.wikipedia.org/wiki/Edward_T._Hall).

distances, the humans of the whole Earth can develop a sense of kinship, that "we are in this together," a perception never fully developed to date by the global population in its history. And, hopefully, one that will be coming soon.

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