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ad Astra
THE MAGAZINE OF THE NATIONAL SPACE SOCIETY

VOLUME 15, NUMBER III JUNE/JULY/AUGUST 2003

MODULES

ON THE COVER:
The International Space Station, America's home in orbit.
—Photo Courtesy NASA

PAYLOAD

Background photo: NASA

***AD ASTRA*, which means "to the stars" in Latin, is the motto of the National Space Society, an international membership group dedicated to furthering the exploration and development of space. The magazine *AD ASTRA* is only one of many NSS activities aimed at creating a spacefaring civilization. For more information on NSS call 1-202-543-1900 or visit www.nss.org.**

THANK YOU, KEN

Lt. Col. F. Kenneth Schwetje (USAF Ret.)

Kirby Ikin
Chairman of the Board of Directors

The NSS family lost one of its own on June 24, 2003, when Lt. Col. F. Kenneth Schwetje (USAF Ret.), NSS Board Member and General Counsel, passed away. Ken first became associated with NSS in the late 1980s, when he helped organize the Law & Space Symposium for the 1989 ISDC in Chicago, bringing in the Air & Space Law Section of the Federal Bar Association as a co-Sponsor and helping assemble a prestigious group of participants. Ken made himself available to us as an unofficial resource through the years before assuming his various official roles.

A native of New Jersey, Ken started his military career as an attorney in the United States Marine Corps and later transferred to the Air Force, where he had a distinguished military career specializing in air and space law. While in the Air Force, Ken earned a Masters of Laws in Space and Aviation Law from McGill University and became a world-known expert in space law issues. He held a series of challenging positions dealing with space law and policy as Chief of Air and Space Law, HQ USAF, at the Pentagon. Ken was responsible for developing and advocating the Air Force positions on many important space policy issues, such as SDI, space treaty interpretations, commercial uses of government launch facilities, and the use of the International Space Station. After the Air Staff, Ken was assigned to the Joint Chiefs of Staff, in the international negotiations and agreements division. Among a number of duties, he participated in the UN study on the military uses of space, evaluated ballistic missile defense programs for compliance with international treaties and domestic law, and was a delegate to the Standing Consultative Commission in Geneva.

After retiring from the USAF, Ken worked for defense contractors on classified space programs. For the past six years he was engaged in the private practice of law. Most recently he was with the firm of Pierson & Burnett L.L.P. and represented many of the major aerospace companies in both the United States and Europe. In addition to his roles with NSS, Ken also has served as the Committee Chairman for the Space Law Committees of the American Bar Association, the Federal Bar Association, and the president of the U.S. Section of the International Institute of Space Law. Ken was one of the founders of the International Moot Court Space Law Competition and regularly served as a judge at U.S. competitions, and also taught space law and policy at the Columbus School of Law (Catholic University) and the National Law Center (George Washington University).

His contributions to the field of space law will be long remembered, but, more importantly, we will miss our friend and colleague. Thank you, Ken.

Kirby Ikin

NSS Director Testifies Before Senate

NSS Executive Director Brian Chase told the U.S. Senate Science, Technology and Space Subcommittee April 2nd that low-cost access to space is the key to an expansive space program. "In light of the loss of Columbia, it is more important than ever for our nation to address the issue of how we transport people and cargo to and from space," Chase said. The NSS Director called for support for the resumption of space shuttle flights, shuttle improvements, development of a back-up system to launch astronauts to the International Space Station, and investing in the next generation reusable launch vehicle. These steps were key in opening up the space frontier, Chase said. "No society has ever gone wrong opening up the frontier, and we shouldn't stop now."

NSS Executive Director Brian Chase at his appearance before the U.S. Senate Subcommittee on Science, Technology, and Space to discuss the future of space transportation and human space exploration.

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MISSION CONTROL

spacebeat
BY JOHN KROSS

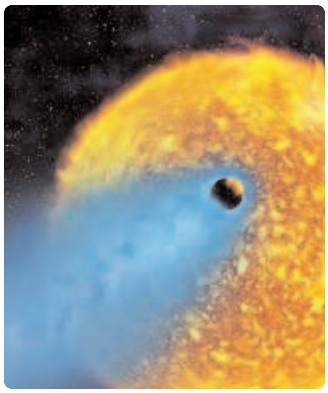
what's up
BY ASTRO-USU

SUN SETS SULTRY SEASON

Global warming might have less to do with hot air than sunburn according to new sun-centered research. Since the late 1970s, the amount of solar radiation has increased by nearly .05% per decade during times of quiet sunspot activity. Although the inferred increase of Total Solar Irradiance (TSI) – the radiant energy received by the Earth from the Sun – in the last quarter century is not enough to cause notable climate change, the trend would be important if maintained for a century or more. "This trend is important because, if sustained over many decades, it could cause significant climate change," said Richard Willson, a researcher affiliated with NASA's Goddard Institute for Space Studies.

To investigate the possibility of a solar trend, Willson carefully pieced together long-term solar irradiance data from overlapping records of six satellites in orbit since late 1978. The data showed a significant positive trend (.05% per decade) in TSI between the solar minima of solar cycles from 1978 to the present. If that trend "persisted throughout the 20th century, it would have provided a significant component of the global warming…over the past 100 years," Willson said. While sultry days are ahead if the trend continues, climatologists looking on the sunny side predict the new data can help distinguish between solar and man-made influences on climate.

NASA



NASA

Illustration of the scorched extrasolar planet 209458b.

HOT BODY DISAPPEARS

For the first time, astronomers using NASA's Hubble Space Telescope have observed the atmosphere of an extrasolar planet evaporating into space. Like a moth drawn to a flame, the scorched planet, called HD 209458b, orbits only 7 million kilometers (4 million miles) from its yellow, Sun-like star. Although HD 209458b orbits too close to its parent star to be photographed directly, astronomers were able to observe telltale shadows of the planet as it blocked light during transits across the star's disk. In addition, starlight passing through the planet's atmosphere revealed a startling drop in hydrogen emission, which can best be explained by a hot hydrogen atmosphere – resembling a comet tail – trailing behind the singed planet.

"The atmosphere is heated, the hydrogen escapes the planet's gravitational pull and is pushed away by the starlight, fanning out in a large tail behind the planet – like that of a comet," explained astronomer Alain Lecavelier des Etangs. Astronomers estimate that at least 10,000 tons of hydrogen gas escape HD 209458b each second. Much of the planet – known as a "hot Jupiter" – may eventually disappear, leaving only a dense core. Such onetime gas giants must have formed in the cold outer reaches of the star system and then spiraled into close orbits, where evaporation of the atmosphere plays a role in setting an inner orbital boundary. HD 209458b's orbit is only one-eighth the size of Mercury's.

STARDUST IN YOUR EYE

The U.S. space agency, which launched its own Stardust mission in 1999, might have collected the real stuff closer to home. NASA claims to have amassed interplanetary dust particles (IDPs), made from bits of ancient stars, during high-flying U-2 aircraft flights in the Earth's stratosphere. "The stardust grains…are typical of the kinds of dust that were available at the beginning of our solar system. These were the building blocks of the sun and planets," said Lindsay Keller, a researcher at NASA's Johnson Space Center.

The discovery was made possible by using a new kind of ion microprobe, which measures isotopic ratios on scales much smaller than previously possible. This is essential for identifying stardust grains, because, "they have isotopic ratios very different from anything in the solar system," said Scott Messenger, an astrophysicist at Washington University. Most of the collected IDPs range in size from 5 to 50 millionths of a meter, and often contain crystalline grains clumped

together in sizes of 100 to 500 billionths of a meter. "The fact that these IDPs are rich in stardust and molecular cloud material suggests that they have remained essentially unchanged from the time the solar system formed, 4.5 billion years ago," said Messenger.

NASA Selects Next Explorer Mission

A swarm of spacecraft, designed to fly through the space storms that cause aurora, has been chosen as the next mission in NASA's Medium-class Explorer (MIDEX) program. Collectively dubbed the Time History of Events and Macroscale Interactions during Substorms probes, or THEMIS for short, the five-satellite mission will be launched in 2007 to investigate global reconfigurations of the Earth's magnetosphere. The orbits of the satellite quintet will be carefully coordinated to line up every four days to allow identical suites of electric, magnetic, and particle detectors to track aurora disturbances.

Explorer-class missions are intended to provide frequent, low-cost access to space for physics and astronomy missions with small to mid-sized spacecraft. "The Explorer program allows the science community to identify the most compelling science questions and then design the most effective mission to answer those questions," said Edward Weiler, NASA Associate Administrator for Space Science. "The mission we've selected will directly address the science goals of the NASA strategic plan within a focused, moderate sized project," he added.

NASA also selected, as a mission-of-opportunity, an instrument for the Extreme Universe Space Observatory (EUSO) mission of the European Space Agency. EUSO will study the most energetic particles in the universe. From its location on the International Space Station, EUSO will look down on the Earth's atmosphere to observe the characteristic blue light that high-energy cosmic rays generate after hitting the Earth's atmosphere.

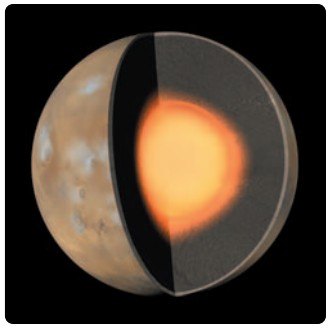
Another mission called the Widefield Infrared Survey Explorer (WISE) also remains on NASA's wish list. If built, WISE would train a four-channel, super-cooled infrared telescope to survey the entire sky with 1,000 times more sensitivity than previous infrared missions. A decision on proceeding to flight development will be made in 2004. Two MIDEX missions are already airborne, the Imager for Magnetopause-to-Aurora Global Exploration (IMAGE), launched in 2000, and the Wilkinson Microwave Anisotropy Probe (WMAP), launched in 2001. A third MIDEX mission, the Swift Gamma Ray Burst Explorer, is slated for a rocket ride in December 2003.

Mars is a Softy Inside

New research suggests that Mars, the blood-red planet named after the Roman god of war, may really be a softy inside. Researchers at NASA's Jet Propulsion Laboratory analyzing three years of radio tracking data from the Mars Global Surveyor spacecraft, concluded that the Red Planet does not have a completely solid iron core, but instead is made up of either a completely liquid iron core or a liquid outer core with a solid inner core, much like Earth or Venus. "Earth has an outer liquid iron core and solid inner core. This may be the case for Mars as well," said Charles Yoder, a planetary scientist at JPL.

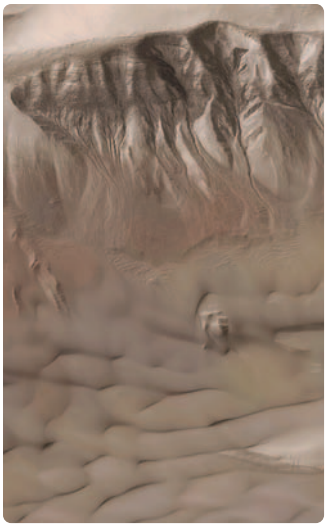
The JPL team used Doppler tracking of radio signals emitted by the Global Surveyor spacecraft to determine the precise orbit of the spacecraft around Mars, and, by inference, tidal bulges on Mars due to the gravitational pull of the Sun. "By measuring this bulge in the Mars gravity field we can determine how flexible Mars is," explained Yoder. "The size of the measured tide is large enough to indicate the core of Mars cannot be solid iron but must be at least partially liquid." Combining this data with information on Mars' precession rate indicated the core is about one-half the size of the planet, as is the case for Earth and Venus, and has a significant fraction of a lighter element such as sulfur.

In addition to measuring the Martian interior, Global Surveyor has also been able to estimate the amount of ice sublimated, changed directly into a gaseous state, from one pole into the atmosphere and then accreted onto the opposite pole. "Our results indicate the mass change for the southern carbon dioxide ice cap is 30 to 40 percent larger than the northern ice cap, which agrees well with the predictions of the global atmosphere models of Mars," said Yoder.



NASA

Mars may have a liquid iron core.



NASA

Martian gullies.

Snow Melt Blamed for Martian Gullies

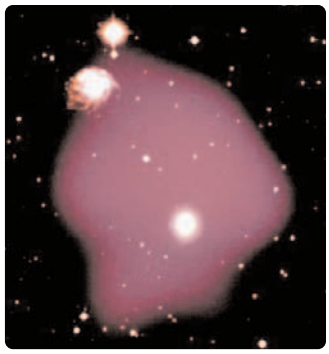
Just as winter weather fosters pothole hell here on Earth, new images from NASA's Mars Odyssey and Global Surveyor spacecrafts suggest that melting snow is the cause of eroded gullies on Mars. According to Philip Christensen, the principal investigator for Odyssey's camera system, at least some Martian gullies are created by trickling water from melting snow packs, not underground springs or pressurized flows, as had been previously suggested. Christensen proposes that gullies are carved by water melting and flowing beneath snow packs, where it is sheltered from rapid evaporation in the planet's thin atmosphere. "The Odyssey image shows a crater on the pole-facing side has this 'pasted-on' terrain, and as you come around to the west there are all these gullies," said Christensen. "I saw it and said 'Ah-ha!' It looks for all the world like these gullies are being exposed as this terrain is being removed through melting and evaporation."

Christensen points out his melting snow hypothesis explains why gullies occur preferentially on the cold face of the slope at mid-latitudes. "Snow on Mars is most likely to accumulate on the pole-facing slopes, the coldest areas. It accumulates and drapes the landscape in these areas during one climate period, and then it melts during a warmer one. Melting begins first in the most exposed area right at the crest of the ridge. This explains why gullies start so high up." Once he started to think about snow, Christensen began finding other images showing a similar relationship between "pasted on" snow deposits and gullies. NASA's tandem of science orbiters are currently laying the groundwork for locating interesting areas for surface exploration by roving laboratories, such as the Mars Exploration Rovers, scheduled for launch in June of this year.

Far-Flung Supernovae Shed Light on Dark Matter

Astronomers using the Hubble Space Telescope's Advanced Camera for Surveys (ACS) have found two supernovae that exploded so long ago they provide new clues about the accelerating universe and its mysterious "dark energy." Coupled with Hubble's powerful vision, the ACS can pick out the faint glow of the distant supernovae and dissect their light to determine if they are a special type of exploding star – called Type Ia supernovae – that are reliable distance indicators.

Previous studies of Type Ia supernovae revealed that galaxies



NASA

New light on Dark Matter.

are moving away from each other at an ever-increasing speed under the influence of dark energy permeating the universe. However, astronomers had very little data on the transition period between this repulsion phase and the earlier epoch characterized by the tug of gravity. Fortunately, one of the newly discovered supernovae discovered by ACS exploded so long ago the universe may still have been decelerating under its own gravity. "We're trying to fill in a blank region where the universe's rate of expansion switched from deceleration due to gravity to acceleration due to the repulsive force of dark energy," explained Blakeslee. "The sharper images, wider viewing area, and keener sensitivity of ACS should allow astronomers to discover roughly 10 times as many of these cosmic beacons as was possible with Hubble's previous main imaging camera."

future SPACE future SPACE future

Space Planes We Have Known
What Did the Great Writers Say About Space?
The Politics of Space Support
New Designs in Interstellar Spaceships

Please submit letters, chapter events, and other copy by September 1, 2003 for consideration for the next issue of Ad Astra.

to the stars Ad Astra THE MAGAZINE OF THE NATIONAL SPACE SOCIETY

What's Up?

BY ASTRO USU

Name	Date 2002	Launch Vehicle	Launch Site	Period (min)	Incl (°)	Apogee (KM)	Perigee (KM)
Coriolis	6 Jan	Titan 2	Vandenberg	101.6	98.7	936	742
ICESAT	12 Jan	Delta 2	Vandenberg	96.6	94.0	610	593
CHIPSAT	12 Jan	Delta 2	Vandenberg	96.4	94.0	601	585
STS-107	16 Jan	Columbia	Kennedy	15.94 days	39.0	280	280
SORCE	25 Jan	Pegasus	Cape Canaveral	97.3	40.0	657	617
XSS-10	29 Jan	Delta 2	Cape Canaveral	98.0	39.8	811	524
Progress M-47	2 Feb	Soyuz-U	Baikonur	88.8	51.6	247	195
Intelsat 907	15 Feb	Ariane 4	Guiana Space Center	22.3	7	35949	200

January 2003

6 January: The Coriolis, a $35 million navigation satellite, was successfully carried aboard an Air Force Delta 2 rocket into orbit. The satellite includes two instruments that may be used in the joint civil/military NPOESS weather satellite program. The satellite will become a member of a constellation of 26 spacecraft that provides a precise navigation signal to millions of users around the world. Also on board the booster was a new $40 million micro-satellite that is designed to show innovative propulsion, communication and other power technologies during a 24-hour-long mission. It is a fundamental component of a $100 million program directed by the Air Force Research Laboratory at Kirtland Air Force Base.

12 January: NASA's Ice, Cloud, and land Elevation Satellite (ICESAT) and Cosmic Hot Interstellar Plasma Spectrometer (CHIPSat) satellites launched aboard a Boeing Delta 2 rocket from Vandenberg Air Force Base. ICESAT is part of NASA's Earth science program, while CHIPSat is a NASA University Explorer mission. UC Berkley is overseeing the ChipSat mission, which carries the Cosmic Hot Interstellar Plasma Instrument. Launch of the $298 million program was delayed one day due to a problem with ground support equipment at the pad.

16 January: The Space Shuttle Columbia launched safely into orbit, beginning a 16-day science research mission. The Columbia launched successfully from Kennedy Space Center, with thousands of spectators looking on as seven astronauts embarked into space. The STS-107 launch was originally scheduled for July 2001 and finally launched following a number of delays including technical difficulties and higher preference shuttle flights. The Columbia mission is a committed science endeavor that extends across several disciplines, including physical and life sciences, Earth and space sciences, as well as other educational undertakings. The Columbia will not go to the International Space Station like usual shuttle flights.

25 January: A Pegasus XL rocket launched from Cape Canaveral, carrying NASA's Solar Radiation and Climate Experiment (SORCE) into Earth Orbit. SORCE, which consists of two key instruments: the Total Solar Irradiance Monitor (TSIM) and the Solar-Stellar Intercomparison Experiment (SOLSTICE), which will study the Sun's role in the Earth's climate changes.

29 January: XSS-10, a 28 kilogram micro-satellite, lifted off from Cape Canaveral aboard a Delta 2 rocket carrying a Global Positioning Satellite. Also aboard the booster was a small demonstration satellite. Both payloads will showcase the capabilities of new low-cost micro-satellites, which weigh less than 100 kilograms.

February 2003

1 February: The space shuttle Columbia and its seven-member crew have been lost. NASA's last communication with the shuttle was at approximately 9 a.m. EST. Columbia carried seven astronauts: commander Rick Husband, pilot William McCool and mission specialists Kalpana Chawla, Laurel Clark, Mike Anderson, David Brown and Israeli payload specialist Ilan Ramon.

2 February: An unmanned Russian supply vessel launched from the Baikonur Cosmodrome on its way to the International Space Station. The Progress M-47 carried water, food, fuel and oxygen to the three-man crew that is on board the ISS. It is unclear what impact the Columbia disaster will have on future ISS missions.

12 February: For the second consecutive day, bad weather postponed the final launch of the Ariane-4 rocket from a launchpad in Kourou, French Guinea. After 23 years of work, the Ariane-4 is scheduled to perform its last flight by carrying the 4.7 ton Intelsat-907 communications satellite into orbit.

15 February: The Intelsat 907 was launched from Kourou, French Guinea aboard an Ariane 44L rocket. Intelsat will provide communication services for the Americas, Africa and Europe. The increased power of the Intelsat spacecraft provides greater signals for digital and communication services and will offer improved video, voice and data broadcast services around the world.

The 2002 Chapter Awards

Jim Plaxco

The 2003 International Space Development Conference was the site of the presentation of Chapter Awards for the year 2002. The presentation of the awards occurred at the Sunday night Awards Banquet. 2002 was a hard year - not just for the NSS and its chapters but also for the economy and society as a whole. In spite of these hardships, the chapters of the National Space Society have been able to call upon a core of dedicated volunteers who have the vision and motivation to work for something grander than mere self-interest. In reading through all of the Chapter Annual Reports, I was struck by just how much our chapters had accomplished in 2002.

Elizabeth Barrett Browning wrote "how do I love thee, let me count the ways." For this article, I write "How do chapters promote space, let me count just a few of the ways." Chapters give the NSS the personal touch. They do this by sponsoring activities and providing public education opportunities in the communities in which they are located. As any good businessman or politician can tell you, the personal touch can make all the difference in the world. The examples that follow are meant to provide a feel for the diversity of activities that the fifty-plus NSS chapters were engaged in during 2002.

Kirby Ikin, Barry McCool, Marianne Dyson, Brian Chase at the ISDC 2002 Awards Dinner.

In one novel outreach activity, the Heart of America chapter (Kansas City, Missouri) sponsored the "William Bent Station" over a period of 15 weekends. For 15 weekends local youth were provided with the opportunity to participate in a camp-out that simulated a weekend-long "Space Camp" mission. This was done in conjunction with the local Mars Society chapter — an example of the type of win-win scenario we achieve through cooperation with our fellow pro-space organizations.

Another example of this cooperation occurred in Chicago when NSS chapter volunteers from the area's three chapters helped to staff the Mars Habitat that was on exhibit at the world-renowned Adler Planetarium. What neither group could do on its own was accomplished by their working together.

In addition to the programs and displays they provided for the LOSCON convention, the OASIS chapter (Long Beach, California) had a Mars Rover simulator roaming the convention floor. They also passed out Mars Bars as a part of their "Take A Piece of Mars" promotion.

The Tucson Space Society (Tucson, Arizona) promoted a sense of family amongst chapter members by featuring potluck dinners as their chapter meetings.

The Sheboygan Space Society (Sheboygan, Wisconsin) created a special exhibit for their community's "Rockets for Schools" weekend-long exhibition. Their display was the largest at the exhibition and attracted the attention of Wisconsin's Lieutenant Governor who lingered at their display and discussed space policy with chapter members.

The Philadelphia Area Space Alliance (Philadelphia, Pennsylvania) had a special exhibit at the New Jersey State Museum in conjunction with NASA's traveling ISS exhibit.

The Queensland Space Frontier chapter (Nundah, Queensland, Australia), as a part of their Literacy Project, has been working with the Nundah Library. One of the things they've done is to create educational pro-space bookmarks for the library to distribute. According to library staff, these bookmarks are a hot item with the local schoolboys. Additionally, the chapter has donated its book collection, along with current magazine subscriptions, to a local school library and a special school library so that these materials would be readily available to inspire the next generation of space explorers and scientists.

The San Antonio chapter (San Antonio, Texas) has been working with the Galm Elementary School on a Young Astronauts chapter.

The Wichita chapter (Kansas) judged and presented awards for student projects in the Wichita State University's College of Engineering and National Institute for Aviation Research's Engineering Open House and Banquet. Their chapter also participated in the establishment of Ad Astra Kansas Day with the governor reading a proclamation drafted by the chapter.

The German Space Society chapter was able to get ISS Commander Saletin to carry one of their chapter's logo cards up to the International Space Station.

The Sacramento L5 chapter (Sacramento, California) is working on a prototype H2O2/kerosene rocket engine and has also worked with JP Aerospace on a balloon-assisted launch system. The President of JP Aerospace also happens to be a chapter member.

The Awards

Chapter Awards are broken out into two major categories: Special Merit Awards and Chapter Excellence Awards. Special Merit Awards are presented to those chapters whose programs and/or projects were of outstanding quality. The Chapter Excellence Awards are the highest awards a chapter can receive and is given based on overall excellence and commitment to the NSS vision. Within these two categories, subcategories for which awards were presented are:

- Chapter of the Year
- Community Service
- Education
- Explorer
- Public Outreach
- Publicity and Media
- Service to the Society

All Photos: Jim spellman NSS/Western Spaceport Chapter

Kirby Ikin presents Barry McCool with the Space Pioneer Award for the crew of STS-107.

Special Merit – Publicity and Media Award

The Publicity and Media Award is given to that chapter which best uses the mass media to deliver its message to the general public. The 2002 Special Merit - Publicity and Media Award was presented to the DC-L5 chapter (Arlington, Virginia) who continue to produce the very successful "Around Space" series for public access television.

During 2002, the DC-L5 chapter produced nine new episodes for broadcast on the Fairfax Public Access TV station. The show is broadcast three times per month with a potential audience of 250,000 per episode. The "Around Space" series also received coverage in a December 2002 issue of the Washington Post.

Earlier this year the chapter also created a Public Service Announcement as a tribute to the crew of the Columbia.

Jim Plaxco presents DC-L5 with the Special Merit – Publicity and Media Award.

Special Merit – Explorer Award

The Explorer Award goes to a chapter that is working on an engineering project that furthers the goals of our society. This year the award was given to a chapter whose project combines cleanliness with education and a journey into space. The 2002 Special Merit - Explorer Award was presented to the Clear Lake Area NSS Chapter (Clear Lake, Texas) for their "Washing Machine for Space Get Away Special" project. The project is being done in conjunction with students at the Hildebrant Intermediate School. The Project Manager is Francis Govers.

Jim Plaxco presents Norman Wille, NYC-NSS with the Special Merit – Service to the Society Award.

Special Merit — Service to the Society Award

The Service to the Society Award is presented to that chapter whose project represents a special benefit to the NSS organization as a whole.

The 2002 Special Merit - Service to the Society Award goes to the New York City NSS chapter (New York, New York) for their "Winter Space Ball" fundraiser, which generated a profit for the chapter of $1,000, half of which was donated to our national organization.

In addition, the New York chapter is the sponsor of an excellent lecture series and has an excellent web site located at http://www.nssnyc.org/

Special Merit — Community Service Award

The Community Service Award is presented to the chapter whose mix of educational, outreach, and other activities are of particular benefit to their community. The 2002 Special Merit - Community Service Award was presented to the Middle Tennessee Space Society (Burns, Tennessee).

During 2002 the chapter made numerous presentations to local school children and to children at their university's day care program. They also participated in the "Girl Scout Jamboree Astronomy Night" and made monthly presentations at the local observatory. They provided presentations and displays for the local science museum's "World Space Week" activities. Monthly meetings at the local arts center, the Renaissance Center, featured educational displays in the center's public areas, attracting the attention of anywhere from 20 to 200 visitors per meeting. The chapter also produces an hour-long weekly public access television program "Space TV."

Uniquely, as a part of a fundraising silent auction to benefit the local science museum, the chapter successfully auctioned their president Chuck Schlemm, along with a space exploration presentation to the highest bidder.

Jim Plaxco presents NSS of North Texas with the Special Merit – Space Education award.

Special Merit — Education Award

The Education Award is presented to the chapter whose education project is of special significance. The 2002 Special Merit - Education Award was presented to the NSS of North Texas chapter (Arlington, Texas) for a special project with the potential to reach one million of this country's young men and future leaders. One million is approximately the number of boys in the Boy Scouts of America. A key element of the scouting program is the earning of merit badges. The NSS of North Texas chapter accepted the challenge of rewriting the Boy Scouts Space Exploration Merit Badge Handbook. They have produced a handbook over 100 pages long. However their toughest challenge remains - editing it down to 75 pages.

Chapter Excellence — Public Outreach Award

The Public Outreach Award is presented to the chapter whose activities reached the broadest possible audience. The award for 2002 was unique in that it was presented to a chapter based on their Internet activities.

With respect to the Internet: today, chapters have a problem and an opportunity. Many people attending chapter meetings years ago did so because it was about the only way to get information on the latest space projects and to discuss with kindred spirits the latest goings-on in space exploration. Today, there is the Internet. People now have a world of web sites at their disposal where they can get the latest news and images. They have the Usenet where they can argue with others about what's right and wrong with the state of space exploration today. In one respect, the Internet has hurt chapters - space junkies no longer need to attend a chapter meeting to find out what's going on in space.

On the other hand, the Internet provides chapters with new opportunities to expand our base and reach a much wider audience. As the world turns to the web for more and more of the information it uses to decide upon a course of action, NSS chapters must rise to the occasion and make the best use of this new media so as to reach as many people as possible. Use of the Internet brings our ability to do public outreach to a whole new level. Our audience is no longer limited to those people from our community who show up at a local meeting or event — our audience is now anyone who is connected. In terms of shear volume of useful and persuasive information, there is one chapter that stands out. Based on their Public Outreach via the Internet, the 2002 Chapter Excellence - Public Outreach Award was presented to the Lunar Reclamation Society chapter (Milwaukee, Wisconsin). Their web site can be found at http://www.lunar-reclamation.org.

Chapter Excellence — Service to the Society Award

The award for Chapter Excellence - Service to the Society goes to the chapter without whose critical assistance the several NSS events associated with the World Space Congress would not have been the successes that they were. The World Space Congress is a once every 10-year event and is the premier

All Photos: Jim spellman NSS/Western Spaceport Chapter

Jim Plaxco presents the Service to the Society Award to Marianne Dyson of the Clear Lake Area NSS Chapter.

space conference. The 2002 World Space Congress in Houston Texas last October saw the National Space Society as one of its exhibitors. In addition there was the NSS Leadership Symposium with one of that event's speakers being Rep. Nick Lampson (D-TX), the principal sponsor of the Space Exploration Act of 2002. That same evening, there was a very successful fundraising dinner hosted by NSS Board of Governors Chairman Hugh Downs. The dinner also featured an auction of a wide variety of space collectibles.

Because of their activities in support of the NSS at the World Space Congress, the 2002 Chapter Excellence - Service to the Society Award was presented to the Clear Lake Area NSS Chapter (Clear Lake, Texas).

Chapter Excellence — Chapter of the Year Award

The Chapter of the Year Award is presented to the one chapter whose activities on all fronts serve as a model to be emulated by other chapters.

To individually identify here all the activities that the winning chapter participated in during 2002 would take an inordinate amount of space so only a brief overview of their year's activities will be presented.

During 2002, this chapter held 10 membership meetings, staffed 14 public displays, conducted 19 programs, and was even able to work in 2 parties and picnics for its members.

One of this chapter's displays ran for 4 weeks at an IMAX theater. They also:

- participated in a Yuri's Night event at a flight museum
- participated in the "Space Tourism Pioneer Awards" with displays and programs in conjunction with the Space Tourism Society
- conducted numerous programs at local schools and at the Discovery Science Center
- conducted a 6 week long "After School Academy" for middle school students from 3 schools using their Traveling Space Museum
- received multiple press exposures, both print and radio
- are currently working to get Space Camp California reopened at the site of the Queen Mary in Long Beach

Because of the scope of their projects, the frequency of major programs, and the number of people reached via these activities, the 2002 Chapter Excellence - Chapter of the Year Award was presented to the Orange County Space Society (Irvine California).

As you can see, the chapters of the National Space Society accomplished much during 2002. Whether it was judging science fairs, providing speakers for local youth or community groups, or sponsoring letter writing campaigns to draw attention to the plight of our country's space program: chapters play a key role in implementing the vision of the National Space Society. If you are not currently a member of a chapter, then by all means become a member. Use the NSS Chapter Listing either from Ad Astra magazine or online at http://www.nss.org to locate the chapter nearest you. If your community is without a chapter, then consider starting one. For information on how to do this, contact NSS headquarters in Washington D.C. today.

Jim Plaxco presents NSS Chapter of the Year Award to Larry Evans, President of the Orange County Space Society.


NASA
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Bush's First Space Policy

Frank Sietzen, Jr.
Editor-in-Chief
Ad Astra Magazine

On May 13th the Bush administration put its first 'stamp' on U.S. Space Policy, and while it is only the first policy action in an anticipated series, it has a clearly identifiable cast to its contents. The new space remote sensing policy released by the National Security Council has a decidedly free market, conservative slant as it seeks to craft a new cooperative framework between U.S. federal users of space photography and the fledgling industry that is struggling to offer such services. Commercial sources of high resolution images will now be Uncle Sam's primary way of obtaining such images. The so-called "National Technical Means," in English: government-owned satellites, will focus only on that capability that cannot be commercially bought.

It is a landmark step in the evolution of the remote sensing industry, and if matched with budget resources—something that must be defined in the next several weeks in Washington—could trigger actual growth in that space business sector. The two current providers of one meter resolution images from space; Space Imaging and Digital Globe, have struggled to define a purely commercial market outside of government clients. Orbimage is set to launch OrbView 3 into orbit this year, making it the third entrant. And the technology research continues into ever greater optical capabilities from satellite platforms.

The Bush policy also in effect drops restrictions on the design and construction of such advanced spacecraft. But embedded in the policy plan are licensing safeguards and other restrictions on where such future, higher resolution pictures could be sold, and to whom. The new policy might require government-to-government agreements if the buyers were foreign entities, or limit such sales to the U.S. government itself.

Administration sources told this column yesterday that the lead agency to implement the policy would be NIMA, the National Imagery and Mapping Agency. Even it will get a new shine under the conservative administration: it's new name will be the National Geospatial Intelligence Agency.

More space policy changes are ahead, in space transportation and possibly navigation and communications. One by one the Bushies are getting around to space. The appointment of Sean O'Keefe was one step. This new space policy is another. Space Transportation is next, possibly followed by satellite navigation and communications, too.

And, HEAD'S UP: A money-packed special FY04 budget supplemental is heading for the Hill, filled with hundreds of millions in extra funding for space shuttle, OSP, and related projects. Alternate Access is now called cargo services, and may be included. All needed for NASA to fix the Columbia-accident causes and get flying once again.

Stay tuned!!!

To Walk Outside Columbia:

By Winston Scott

I watched the TV in horror as the screen showed white cloudlike contrails streaming across the blue skies over Texas. There should have been only one, but there were several. I suspected something had gone terribly wrong, but I tried to push out of my mind the thought that I might have lost personal friends and colleagues.

I watched helplessly as the news commentators described how NASA mission control was frantically attempting to regain contact with the space shuttle Columbia. The number of contrails told me that it was futile for the controllers to continue to try.

I watched in sadness as the events of the day unfolded and confirmed what I had hoped wasn't true: Columbia had disintegrated.

NASA

Since the loss of Columbia on Feb. 1, the thoughts of my own spaceflight experiences aboard Columbia have resurfaced.

My flight on Columbia in November 1999 was similar in several ways to the February 2003 flight. Both missions were sixteen days long and were focused upon micro-gravity experiments. Both mission crews explored the effects of space on plant growth, heart and lung function, observation of ozone in the earth's atmosphere, and some 80 other evaluations. Both flights consisted of multi-national crewmembers. Besides the obvious difference in the conclusions, there was another significant difference between the two flights. My flight included two spacewalks, which I performed from Columbia's payload bay with my spacewalking partner.

We commonly call it walking in space, but its technical term is EVA or Extra-Vehicular Activity. Clint Eastwood performed an EVA in the 2000 movie *Space Cowboys*. I watched in amusement as he effortlessly flew out of his space shuttle's airlock, cruised across the payload bay, and snapped on his jet pack. Big Clint then zoomed all over outer space, Superman style, saving the day.

Clint, and yes, I am a big fan, made it look so easy but in reality, walking in space is a complex, physically demanding, and risky activity. And although it's called "walking" you actually float, moving your body from place to place, very slowly, using handles mounted at strategic locations in the space shuttle payload bay. The spacesuit, or EMU (Extravehicular Mobility Unit) weighs over 300 pounds on *E*arth. Its weight disappears in space but its mass remains. In addition to the mass of the EMU, astronauts must maneuver their own body mass plus the mass of the tools attached to the spacesuit. This means that EVA astronauts routinely move at least 600 pounds using only their hands and forearms. On my Columbia flight, my partner and I maneuvered close to 3,000 pounds when we manually captured a malfunctioning satellite.

The jet pack Clint used in *Space Cowboys* is in reality called SAFER (Shuttle Aid For EVA Rescue) and is used only in cases of emergency. For example, an errant space walking astronaut, floating 'loose' in space, could use the SAFER unit to fly back to the space shuttle.

NASA suspects tile damage led to Columbia's breakup and many people have asked me why the ill-fated Columbia crew could not have performed a spacewalk to assess and repair damage to Columbia's heat protection tiles. The crew in fact ***could have*** performed a spacewalk but not for the purposes of repairing damage to the shuttle structure.

The crew had been trained to perform a contingency spacewalk in response to specific problems. For example, if the payload bay doors had failed to fully close and/or lock into position the EVA crew would have donned their EMU's, exited the space shuttle and used special winches, ropes, pulleys, latches, and other tools to close and lock the doors. Such an EVA would have been absolutely necessary because the space shuttle cannot safely return to earth with the payload bay doors, or any other door, window or hatch not fully closed. Reentry, with any space shuttle cavity open, would lead to structural failure and destruction of the vehicle. Also, the contingency EVA crew could not have simply floated themselves to a position to inspect Columbia's left wing because there were no handles mounted in the necessary locations to allow such an inspection. There simply wasn't anything for the astronauts to hold on to.

Columbia's micro-gravity mission did not require the presence of the familiar 50-foot robot

An Astronaut's Tale

arm (Remote Manipulator System or RMS). The RMS is often used to move spacewalkers to various locations about the space shuttle. Even if the RMS had been installed, its range of motion would not have allowed it to be positioned to put an astronaut in place for an inspection of the left wing tiles. Additionally, the crew could not have used the SAFER jet packs to fly themselves into position for a tile inspection. There was no planned EVA on this mission and thus no SAFER units on board.

NASA considers costs and benefits in deciding whether to perform a spacewalk. EVA may look smooth and graceful on TV and most often it is. Sometimes, however, astronauts inadvertently kick pieces of cargo or bang their bulky spacesuits into shuttle structure. An astronaut attempting to inspect the space shuttle tiles might kick, bang, and ultimately cause more damage to those delicate tiles than already existed prior to the inspection.

Another, more academic, consideration is in order. Even if mission control and the Columbia crew had been able verify tile damage during Columbia's flight, it is highly unlikely that anything could have been done about it. There were over 20,000 tiles on Columbia, each different in size and shape and attached in its own unique position. There is no way to carry 20,000 spare tiles into space. Also, there is no way to install spare tiles while in space. It is currently impossible for an EVA astronaut, or an automated robot, to determine the presence of tile damage, identify and locate the specific tile(s) damaged, remove remnants of the damaged tiles, and install and test the new tiles.

Perhaps the post-accident investigation will result in EVA equipment and procedures for the repair or replacement of space shuttle tiles while on orbit. But it may not. What is important is that NASA spares no effort in improving overall space shuttle safety. Funding must be made available for upgrades and improvements to space shuttle systems, development of new protective materials and equipment for the shuttles, development of new articles of personal protective clothing and equipment for crewmembers, and development of new methods of training personnel. NASA must also continue to cultivate the climate that holds safety as the most important aspect of the spaceflight business.

NASA

Astronaut Scott in one of his "walks."

I remember the day I told my wife, Marilyn, that I had been selected for NASA's astronaut core. She was excited and pleased but shuddered at the thought. "That's dangerous," she said.

"There is danger in everyday living," I told her. "Nothing is 100 percent risk free. Besides, statistically it's a lot safer than the aircraft I've been flying all these years."

Many people ask me if I would fly on a space shuttle again. I never hesitate to answer "yes." The benefits of going into space far exceed the risks. I believe it is important that humans continue to reach, to learn, and to grow. It is only through exploration and growth in knowledge that we are able to provide a better life for everyone. In the case of Columbia, we must identify and correct the problem that doomed the shuttle and her crew and get along with the business of flying in space. And we must resume this space flight business in as safe a manner as possible.

LUNAR TOURISM

To an adult, a vacation on the Moon would be more exciting than Disneyland is for a child. What can we do to realize the dream?

BY DAVID DIETZLER

The lunar siren calls, unlike distant Mars, just a few days away. To an adult, a vacation on the Moon would be more exciting than Disneyland is for a child. Ever since Apollo we have been waiting for the arrival of lunar tourism. Our expectations have been based on the history of aviation with passenger flights coming just a few decades after the Wright brother's first flight at Kitty Hawk. It is now 2003 and lunar tourism is not even on the horizon. What has happened? More importantly, what can we do to realize the dream?

Progress occurs in stages with each stage becoming the platform for launching the next stage. The first stage on the way to lunar tourism is the development of low cost access to low Earth orbit. This was the broken promise of the Space Shuttle. Let's avoid editorializing and place our faith in the power of free enterprise. Where there is a market there are people who want to make money who will cater to that market. I doubt that much of the motivation behind the X-Prize contestants is the desire to win the ten million dollar reward. Those entrepreneurs know that whoever builds a successful rocketplane will attract the investment needed to make more rocketplanes, and there are millions of customers out there waiting in line for a ticket.

First generation sub-orbital rocketplanes with room for just a few passengers will be followed by larger second generation vehicles and eventually full fledged orbital rocketplanes that can take off and land routinely. A trip to low-Earth orbit might cost $100,000 at first. When the price comes down to about $20,000 the mass market will emerge and millions of middle class travelers will visit space very year. A couple of hours in space experiencing the thrill of weightlessness and the incredible view of Earth below could be topped off by landing in a distant country and continuing one's travels. Eventually there will be hotels in LEO made from modules and external tanks launched by reusable heavy lift launch vehicles similar to the Russian Energia or the Ares which has been envisioned for Zubrin's "Mars Direct." The Space Island Group headed by Gene Meyers is already planning orbital hotels made of external tanks.

The first leg of any journey to the Moon will be ascent to Earth orbit. It has been said that LEO is "half-way to anywhere." This is true, but to go beyond Earth orbit and land on the Moon we will need a spaceship built for this task and rocketfuel. We could build a vessel out of external tanks and

Artwork by Vassil Iliev, Space Settlement Design Contest

ferry fuel up to LEO, but this will cost a lot of money. To simply reach escape velocity, loop around the Moon once and aerobrake into Earth orbit on return in a ship like Peter Kokh's Jules Verne we will need a mass of hydrogen and oxygen equal to the mass of the ship. To reach escape velocity and retro-rocket into lunar orbit, spend a few days looking at the lunar surface just a couple of hundred of kilometers below as if we were in a glass bottom boat, then rocket out of lunar orbit and aerobrake back into LEO we will need a mass of hydrogen and oxygen that's twice the mass of the ship. If we reached orbit for $20,000, we can estimate the cost at about $100 per pound. If our ship amasses just 50 tons we will need 100 metric tons of fuel and oxidizer shipped to LEO at a total cost of $22 million. Producing, storing and handling the rocketfuel will add to the cost. If ten people fly on our lunar orbiter we will each pay at least two million bucks each just to ship the rocket propellant to LEO. If we want to land on the Moon the situation just gets more complicated and more expensive.

There are ways to overcome this dilemma. The simplest way would be to build a nuclear thermal rocket engine powered ship that uses liquid hydrogen as a working fluid. With a specific impulse of 900 seconds a single staged rocket could fly directly from Earth's surface to the surface of the Moon. If you ever say the movie Destination Moon, you would agree that this is a science fiction dream come true. If you don't believe me you can do the math yourself: ISP*g=exhaust velocity=900*0.0098=8.82 kps Using the rocket equation and 11 kps to escape+2.4 kps to retro down to the lunar surface= 13.4 kps we find: (e13.4/8.82)= 4.57 That's not an incredibly high mass ratio. A 100 ton ship would need 357 tons of LH2. If we blast off from the Moon also, we add 2.4 kps to get a total delta V of 15.8 kps (e15.8/8.82)= 6 A mass ratio of 6 is not impossible either.

Getting hydrogen for return flight is no problem. We can construct the ship so that we have enough hydrogen after landing to lift off again and aerobrake or send some equipment to the Moon ahead of time to mine ice and produce liquid hydrogen so that we can refuel on the lunar surface. The only real show-stoppers are politics and popular anti-nuclear sentiment. Rather than editorialize, I will simply accept these barriers and search for a different strategy.

It might be cost effective to get rocket propellant from the Moon. As Gerard K. O'Neill made us all realize, mass drivers could launch materials from the surface of the Moon into space with just a small fraction of as much energy as is required to climb out of the Earth's gravity well and this could be done with cheap electricity and no propellant at all. The infrastructure required to do the job would cost hundreds of billions of dollars and it is hard to justify that investment just for the sake of high priced tourism for the privileged few. However, a space industrialization and colonization program could lead to the creation of a cheap, reliable energy supply to the less developed countries in the form of helium 3 and solar electricity beamed down from satellites in GEO or from stations on the Moon. For half the world's people there is only one phone for every one hundred persons and the population is growing. Large telecommunication space stations may be necessary to replace multitudes of small satellites in the future and these could provide cell phone service to customers anywhere in the world without stringing wires all over the Australian Outback or the wilds of Central Asia much less submarine cables to connect all the islands of Micronesia and countless cell phone towers in cities around the world. Factories in space may produce long sought after alloys and pharmaceuticals that revolutionize industry on Earth. We will not import millions of tons of iron from the Moon or an asteroid, but we might discover a way to make an alloy through the mysterious effect of undercooling perhaps that allows the production of motor and turbine shaft bearings that have incredibly long life. Space industry could make enormous contributions to the welfare of billions of poor people on Earth. There is much more at stake than tourism. Subsequently, it is very likely that the Moon and high Earth orbit will be colonized in the next fifty years and materials from the Moon will become available to businesses in space. At first, lunar habitations will be built to house workforces and scientists. In time, industry on the Moon could lead to the infrastructure needed to build hotels and resorts there as well as supply rocket propellant.

Interlunar rockets could burn hydrogen and oxygen from deposits of ice in permanently shadowed craters of the Moon's polar regions. There are six billion tons of ice on the Moon and some of this will be mined to supply rocket fuel and oxidizer in the early stages of lunar industrialization, but this cannot go on forever. Water ice that is converted to propellant will be lost into the vacuum of space forever. If 100 rockets or the same number of flights by one rocket each burn 100 tons of hydrogen and oxygen at a time over the course of a year, the ice will be used up in 600,000 years. If 1,000 rocket flights every year burn 1,000 tons of LH2 and LOX each time, the ice will last 6,000 years. There's quite a bit of the stuff. If 100,000 flights burn 1,000 tons the ice is gone in only 60 years! Since a single typical metropolitan airport handles over a thousand flights every day it is not hard to imagine a time when the Moon's ice resources dwindle faster than our fossil fuel supply seems to have. That ice will be necessary for drinking water, washing, cooking, mopping, farming, aquaculture, cement and plaster making, fuel cell reactants, chemicals for industrial processes; a source of hydrogen for making plastics and silicones when combined with carbon, nitrogen, silicon and oxygen; nuclear reactor coolant, running solar thermal steam turbines, swimming pools, hydro-electric power storage systems, transparent radiation shields, algae ponds, quenching red-hot steel and many other purposes. The Moon's ice is a natural treasure that we cannot afford to waste.

It will be wise to switch to aluminum and oxygen for rocket propulsion as rapidly as possible. Aluminum dust and liquid oxygen have been successfully combined to make a monopropellant that yields about as much performance as solid rocket motors. Rockets that shuttle between the lunar surface and lunar orbit or space stations at L1 and L2 could use Al and LUNOX. Regolith launched from lunar mass drivers could be processed in space to obtain aluminum and oxygen. This propellant could be stored at depots in lunar orbit, at L1 and at L2; and some could be rocketed down to LEO in aerobraking modules. The physics of rocketing out of the L1 region makes it possible for an aerobraking cargo carrier to embark on its flight towards Earth with the sacrifice of some propellant equal to just a small percentage of the vehicle's loaded mass. For this and many other reasons space station ports/depots at L1 and L2 are very appealing.

Aluminum and oxygen is not a very powerful fuel combination. A rocket that travels from LEO to lunar orbit will need a mass ratio of five to one. Flight to L1 would allow more efficiency. If a ship is built based on a 33 ton Shuttle external tank its total mass might be 150 tons. Six hundred tons of Al/LOX would be needed for a one way flight. Thousands of flights every year would place a large demand on the Moon miners, mass drivers and regolith smelters. An external tank is pretty big, but

I don't see more than 100 people spending a few days together inside one of those things en route to the Moon. An E.T. has a total of about 2000 cubic meters in the hydrogen and oxygen tank. One hundred people would get 20 cubic meters apiece. For comparison, Skylab had 100 cubic meters per occupant, a nuclear submarine has about 70 cubic meters per sailor and the Russian Salyut had 50 cubic meters per cosmonaut. Things are going to be crowded!

Can't our trip to Disneyland be better than this? Ion drive is not the answer. It takes to long to spiral out through the Van Allen radiation belts. Fusion might be a great way to propel a large space liner, it ever is controlled. Even if fusion is ever controlled it might be that fusion reactors are far too massive for decent rocket propulsion systems. Antimatter is even farther a field in the science fiction dreams of tomorrow. What about no propulsion at all? It turns out that that is the best! The interlunar cycling station could loop around Earth at about 500 kilometers altitude and race out to a distance of roughly 470,000 kilometers in a 13.66 day orbit. Once a month, travelers could board an aluminum/oxygen burning E.T. Rocket or "taxi" in LEO and rendezvous with the cycler as it rounds the Earth. Since they only have to be on the taxi for a few hours, about 400 of them could be packed in there like a Jumbo Jet or Air Bus of space. Once they reach the cycling station consisting of several rings of a dozen external tanks rotating to produce "artificial gravity" they could enjoy roomy cabins with large screen flat panel TVs, king sized Murphy beds, CD stereos, a telephone and computer, a coffee maker and private bathrooms with hot showers. The cycling station will also feature dining rooms, bars, dance floors, a gym, hot tubs, gardens, a library, all the comforts of civilization and a sick bay equipped to handle the most dire medical emergencies. Since the cycling station will be crawling along at apogee but careening around Earth at nearly escape velocity at perigee it will race through the Van Allen belts so rapidly that radiation exposure will be minimized. Since the cycler doesn't have to rely on massive amounts of propellant to do its job it can be heavily shielded for added good measure. The journey to apogee will take about a week. At or near apogee the travelers will board the taxi again and fly over to the L2 spaceport. They will then descend to the lunar surface in Al/LUNOX burning MoonShuttles. The taxi will be serviced by spaceport crews and reloaded with Al/LUNOX launched up to lunar orbit with mass drivers and hauled over to the spaceport by slow moving but efficient nuclear electric freighters. In the more distant future, 25 mile long mass drivers rather than rockets will launch passenger modules from the surface of the Moon and space elevators might move tourists between the lunar surface and the spaceport at L2. Cycling stations of the more distant future will be as massive as ocean liners but more voluminous because they will be made of aluminum, magnesium and titanium instead of steel and carry thousands of tourists. A system of one hundred of these inter-lunar luxury liners each carrying 2500 passengers could transport three million people to the Moon every year. If a two week lunar vacation including flight to LEO, transit via cycling station, MoonShuttle flights; hotel fees, meals, tours, spacesuit rentals and travel by lunar surface railways comes up to merely $200,000 per person, lunar tourism at this rate will be a $600 billion a year business. Since a Hummer costs about half this and the three million people every year who get to take this trip will be the wealthiest citizens of the Earth, it's easy to foresee multimillion dollar trips and an industry worth well over a trillion dollars a year that employs as many people as the auto industry. Lunar tourism will be a great way to redistribute the wealth through the power of capitalism rather than socialistic government programs and keep idle hands busy. That should make somebody happy.

If a two week lunar vacation including flight to LEO, transit via cycling station, MoonShuttle flights; hotel fees, meals, tours, spacesuit rentals and travel by lunar surface railways comes up to merely $200,000 per person, lunar tourism at this rate will be a $600 billion a year business.

SPACE: FINAL FRONTIER OR THE NEXT BATTLEZONE?

By Travis K. Kircher

"The exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind."

Article 1 The 1967 Outer Space Treaty

October 10, 1967. With the signatures of the United States, Great Britain, the Soviet Union and eighty-eight other countries, the 1967 Outer Space Treaty went into effect.

Essentially an effort to pacify the space race, the treaty effectively banned space as a medium for weapons of mass destruction and bound the signatory nations to a pledge to use both it and the heavenly bodies for peaceful purposes only. With roots in a number of United Nations resolutions, the treaty had been a work in progress dating back to August 1957, just two mere months before the launch of the Soviet satellite Sputnik.

Craig Eisendrath is a faculty member of Temple University in Philadelphia. He is also one of the drafters of the 1967 Outer Space Treaty, having worked as a foreign service officer for the State Department off and on during the late 1950's and 1960's. He described the political state of the world during that time.

"I think the country was worried that the Soviets had kind of stolen a technological march on the United States," he explained. "There was a lot of immediate speculation when the space age started...there was this sort of sense that space dominance would give immediate military dominance."

The military implications were not the only issues the drafters of the treaty would have to tackle. There were other more fundamental questions that Eisendrath said hearkened back to the 16th Century.

"There were a lot of very basic new questions like 'Who owns outer space?' Do you lay claim to it like Columbus did in the name of King Ferdinand and Queen Isabella? Those basic questions were really on the floor at that point," Eisendrath said.

While working on the treaty, Eisendrath said the United Nations drew from a number of existing legal models.

"Basically, we were trying to craft law for outer space," Eisendrath said. "One of the problems we faced was what would be the appropriate model? Should we use the law of the sea? Should we use the laws pertaining to aviation? Interestingly enough, we didn't. The model that we used was the law for Antarctica."

Eisendrath explained that the Treaty of Antarctica, which was signed in 1959, provided an excellent framework to work with because among other things, it 1) provided for the free access of the signatory nations to Antarctica for the purposes of peaceful investigative study, 2) denied any territorial claims of any one particular nation to Antarctica and 3) prohibited the use of nuclear weapons in Antarctica. Each of these was a stipulation that the United Nations felt could be transferred to both space and the heavenly bodies.

Thus the path was laid for the peaceful exploration of the universe. But all treaties are subject to interpretation...

Classified Payloads

Although the 1967 Outer Space Treaty banned weapons of mass destruction—both nuclear and otherwise—beyond the atmosphere, it didn't go so far as to remove the military's presence in space altogether.

Among other things, the space shuttle program has been used to fly classified payloads for the Department of Defense on eight separate occasions, beginning with STS-51-C in 1985 and ending with STS-53 in 1992.

The debate continues to rage between those who believe those who feel that it offers a unique opportunity to

Astronaut John Blaha was the pilot assigned to STS-33—the fifth shuttle mission to fly with a D.O.D. payload. Blaha refused to reveal the nature of the still-classified payload, but noted that he was particularly proud to have played a part in the successful operation.

"I'll be honest, from my viewpoint, flying STS-33 wasn't any different from STS-29 or STS-43," Blaha said, referring to other unclassified science missions he was assigned to. "The payloads were just labeled 'Classified'—that was the only difference. But I know what we did was very important and I would always say that it's a shame that we can't tell people what we were doing because what we were doing was pretty significant as it turns out."

Eyes in the Skies

The U.S. military also utilizes hundreds of satellites currently in orbit around the earth. Of that amount, sources say that a classified number are comprised of spy imaging satellites—satellites with the ability to take detailed images of the ground.

Despite their military applications, Eisendrath emphasized that the presence of such satellites does not in his view violate the terms of the 1967 Outer Space Treaty.

"It (the treaty) doesn't demilitarize outer space," Eisendrath explained. "What we've relied upon since the opening of the space age is the kind of surveillance of the earth which is only possible through outer space. You can't over-fly in the airspace in a country like the Soviet Union, but in outer space you were able to observe what they were doing. So in a certain sense, there was a huge gain for disarmament by the fact that we had observation satellites."

Eisendrath further emphasized that even orbiting satellites used to guide and direct missiles—such as the Joint Direct Attack Munition (JDAM) used by U.S. forces in Afghanistan—do not violate the treaty, since the weapons originate from the ground and not in space.

When it comes to the number of spy imagery satellites the United States has currently orbiting the earth, experts tend to agree that there are less than a dozen. Department of Defense sources refused to comment on the resolution of the images taken by these satellites, but Porcher L. Taylor III—an assistant professor at the University of Richmond and an expert in satellite diplomacy and newsgathering—pointed to media reports that the resolution was approximately four to six inches.

"Hypothetically speaking, if that's the case—and I emphasize hypothetically—then that would arguably mean that you could see a softball or a large grapefruit from outer space," Taylor said.

He called attention to recently declassified leaflets published by the Department of Defense and distributed over Iraq. The leaflets warn the Iraqi people not to use weapons of mass destruction and show a picture of a satellite orbiting the earth along with the words "We can see everything".

"Think of the implications of that," Taylor said. "We're saying 'If you use chemical or biological weapons against U.S. troops, we'll know you're doing it because we'll be able to read your dog tags. Or we'll be able to count the freckles on your face'. You see what I'm saying? This is incredibly bold. I never thought I'd live in a lifetime where we would see that kind of candor, although it's clandestine candor and psychological candor from the military."

James A Lewis, a senior fellow and the director of technology policy at the Center for Strategic and International Studies seems to agree with Taylor's assessment, though with slightly more skepticism. He served for 16 years with the Departments of State and Commerce where he was an expert in encryption policy and satellite and computer export policies. Lewis refused to get into the specifics of his knowledge of satellite imagery resolution, although he did say that facial characteristics could be identified in a satellite image, but only if the conditions were favorable.

"Maybe in an ideal, perfect shot, but in general, that might be a little hard," Lewis said. "It depends. If you went out and stood in your yard and looked up and waved and said 'Hi' right when it was going overhead...they could get pretty close to that."

Lewis recalled instances during the Cold War when American troops would use the Russians' spy imaging satellites to play jokes on them.

"If you put out letters that were six feet long or ten feet long, you could spell a message—if you thought that you were being imaged," he said. "We used to do things like put signs out that would say 'Hi Mom' for the Russians. It's not worth the effort because sometimes you have to trace out fairly big letters."

At a time when America spy satellites dominate the skies, other countries have found ways to keep their secrets from being imaged. Both Lewis and Taylor noted that the flyover times of most military satellites have been calculated by amateur enthusiasts and are available on many websites. With this information at their fingertips, foreign countries are able to hide vehicles and equipment until the satellite passes out of range.

space should only be used for scientific endeavors and defend against terror.

Taylor said that some countries find ways to keep equipment permanently hidden.

"You saw with the Russians for example—and with the Chinese now and even the Iraqis and Iranians—people will build sheds," he explained. "The shed will basically be just a roof on poles and the whole purpose of the shed—it might be over a plant or it might be over equipment or it might be over an unloading facility in a port—is just so they won't be able to be imaged from space."

The Missile Defense Controversy

But Eisendrath does not support all of the military's space-based initiatives. Recently, President Bush announced plans to deploy a new missile defense system that calls for up to sixteen long-range missile interceptors to be located at Fort Greely, Alaska and four at Vandenberg Air Force Base in California. It also involves the deployment of air-transportable Patriot Advanced Capability-3 (PAC-3) systems to intercept short and medium range ballistic missiles. As part of the system, President Bush vows to pursue futuristic defense mechanisms in land, sea, air and space.

That last medium makes Eisendrath jittery.

"What's happened in recent years that is different is that they are...having weapons originate in outer space," he said. "The three types we're talking about are kinetic weapons—that is, weapons which basically make physical contact with things both in outer space and earth, energy weapons—which are laser weapons or directed energy and the third are nuclear weapons."

As the author of *The Phantom Defense: America's Pursuit of the Star Wars Illusion*, Eisendrath argued that Bush's proposed missile defense shield would be ineffective because the technical capability to intercept incoming missiles is not present.

He is not alone in his fears. Stephen Young is a senior analyst and a Washington representative for global security with the Union of Concerned Scientists. He explained his belief that the U.S. decision to withdraw from the Anti-Ballistic Missile Treaty is provoking countries like North Korea to launch a new nuclear arms race.

"We already have a defense system in place," Young said. "It's called deterrence and it works very well. The severe drawback to a missile is that we know precisely where it came from, so if North Korea or Iraq or an imbecile country...ever got to a position where they did try to attack us, they would be obliterated. They would go away."

Young argued that a missile defense shield would eliminate North Korea's deterrent and cause them to stockpile nuclear missiles in an effort to maintain an effective defense.

He also blasted the Bush administration's decision to delay the construction of an X-band radar—a key sensing device that enables the missile defense system to detect the exact size and position of incoming warheads—until after the system is completed in 2004.

Young said that without the radar, the missile defense system would be unable to distinguish between actual missiles and balloon countermeasures.

When questioned about whether or not the system could eliminate multiple independent targets, an anonymous official at the Missile Defense Agency refused to comment.

"I'm not going to go there at this point, and I'm not going to go there because it's a hypothetical question and I'm not going to go there because it's too big a question for a simple answer," the source said. "You're looking for a simple answer."

Despite all of these criticisms, proponents of the missile defense system argue that the ever-changing security environment after 9-11 means that threats are less predictable and requires the ability to deal with attacks from unstable nations.

Pentagon spokesperson Ken McClellan scoffed at the idea that North Korea should try to build a nuclear arsenal in response to U.S. missile defense initiatives.

"Now that they (nuclear missiles) are going to be totally useless, they're gonna build more of them?" McClellan asked. "I would encourage you to look at the technologies that we've developed over the last twenty years. We've proved that lasers work. We've proved that missiles launched from aircraft work. We've proved that missiles launched from the ground work. How many technology projects does it take to prove that lobbying missiles at the United States is going to be a futile effort?"

"Look at the devastation in New York on 9-11," the anonymous Missile Defense Agency source added. "Imagine what would have happened if that had been a ballistic missile. Put a price on that. What's that worth? You tell me."

For now, the debate continues to rage between those who believe space should only be used for scientific endeavors and those who feel that it offers a unique opportunity to defend against terror.

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An Ad Astra Special Report:

Healthcare and Safety in the U.S. Space Program

Eleanor A. O'Rangers, Pharm.D. and Linda M. Plush, MSN, CNS/FNP, FRSH

"We've wasted at least 25 of the 30 years of manned spaceflight by neglecting to undertake serious, well-planned scientific investigations of the effects of spaceflight on the human body."

At the time of this statement, in 1993, former Apollo astronaut and U.S. Senator Harrison Schmitt was commenting that his former employer, NASA, had never established a rigorous life sciences program, much less a database of what was learned. Moreover, he expressed concern that NASA did not have a plan in place to effectively manage sick or injured crew members during space missions. Could this harsh indictment be true? After 40 years of manned spaceflight, what *is* the status of astronaut healthcare in space? In order to address this question, one needs to explore the status of astronaut healthcare in the US Manned Space Program from its origins, development and current status. Moreover, if challenges do exist, are there opportunities for ways in which astronaut healthcare can further evolve and improve?

The dawn of space medicine, astronaut healthcare and safety... and problems

Until the advent of German rocketry during World War II, little serious thought was given to the possibility that humans could achieve spaceflight, much less that space healthcare would need to evolve as a new area of medical specialization. The earliest conference addressing possible medical concerns associated with spaceflight can be traced back to 1948, when United States Air Force Major General H. G. Armstrong organized a meeting of physicians and astrophysicists at the USAF School of Aviation Medicine. Aerospace medicine soon became a fledgling specialty of preventive medicine. As interest among scientists and the medical community grew, the need for an organization through which to exchange information concerning space medicine also developed. In 1950, the Aeromedical Association was petitioned to admit a Space Medicine Branch. This petition was accepted in 1951, providing broader recognition of space medicine in the larger medical community.

During the 1950s, the U.S. Air Force and Navy expanded their space medicine training programs and initiated research into the field in the areas of life support, tolerance to acceleration (*g*) forces, and reactions to confinement—topics that were initially extensions of aviation research.

With the launch of *Sputnik* in October 1957, a new sense of urgency infused the space medicine community, as the possibility of humans traveling into space suddenly drew nearer. As the pace of space activities accelerated post-*Sputnik*, little time was afforded to the deliberate investigation of space physiology and medicine in laboratories and ground simulations; indeed, only mission-critical issues pertaining to life support, health, and safety were simultaneously developed along with launch vehicles during the "space race." Indeed, the engineering attitude toward medical research during this era is aptly reflected in former NASA flight director Gene Kranz's opinion of flight surgeons who were concerned with man's ability to function in space: "I had always felt that the flight surgeons were too plodding, too conservative for the rapid evolving [space] program."

When President Kennedy laid forth his mandate to "land a man on the moon by the end of the decade", space mission priorities even more clearly favored an emphasis on engineering capabilities over potential astronaut health. This early deference to the engineering aspects of mission success would come to plague the optimal provision of medical care to astronauts as the space program matured. Indeed, compromises to initial design of the Apollo Command Module (CM) resulted in the loss of three astronauts during a pad fire in 1967. Only after this event was it realized that safety was being compromised in the face of "go fever" to reach the moon by the end of the decade. Changes to cabin gas mixture, the refitting of the CM interior with nonflammable materials were subsequently made. Whenever NASA gets sloppy, astronaut lives are lost; this pattern would again be seen with the *Challenger* accident in 1986.

Moreover, the relative lack of interest in crew health was even further solidified by the astronauts themselves, who all originated as military pilots. As noted by Andrew Chaiken in his book *A Man on the Moon: The Voyages of the Apollo Astronauts*: Pilots

had a saying: There are only two ways you can walk out of a doctor's office - fine or grounded. More than one astronaut had sneaked off to a private physician, who was sworn to secrecy, rather than risk seeing a NASA doctor.

Flight surgeons were hired by NASA in order to justify that the space program was safe; however, a pilot's goal is to fly, and anything that could stand in the way of that endpoint is considered "dangerous" and is avoided at all costs. The roots of the astronaut-flight surgeon "angst" can be clearly traced back to the military aviator-flight surgeon dynamic. As described by Tom Wolfe in "The Right Stuff":

Pilots and doctors were natural enemies, of course, at least as pilots saw it. The flight surgeon was pretty much kept *in his place* in the service. His only real purpose was to tend to pilots and keep 'em flying. He was an attendant to the pilots' vital stuff. In fact, flight surgeons were encouraged to fly backseat with fighter pilots from time to time, so as to understand what stresses and righteous stuff the job entailed. Regardless of how much he thought of himself, no flight surgeon dared position himself *above* the pilots in his squadron in the way he conducted himself before them: i.e., it was hard for him to be a consummate panjandrum, the way the typical civilian doctor was.

This pervasive distrustful attitude toward flight surgeons generally persists today among astronauts, regardless of whether one is a pilot, mission specialist or payload specialist.

In retrospect, it could be said that astronaut healthcare was causality of the short-sighted and politically - motivated design of the US Manned Space Program itself. It is interesting to note that space pioneers such as Konstantin Tsiolkovsky, Hermann Oberth and Wernher von Braun had all concluded that a logical course of events in the conquest of space was the development of earth-orbiting space stations first, then followed by interplanetary exploration. Unfortunately, the Cold War political agenda forced NASA to take a bolder step forward in the "space race": landing on the moon. Decisions regarding "what to do after the moon" were of much lesser consequence when NASA's narrowly-defined, engineering-driven mission was defined in 1961.

The concept of a space station was not completely lost during the 1960's, though perhaps its true objectives were. By mid-1963, exploratory work performed at several of the NASA field centers had concluded that an orbiting space station had a valid rationale.

The primary mission on early flights would be to determine whether man could live and work effectively in space for long periods. The weightlessness of space was a peculiar condition that could not be simulated on earth-at least not for more than 30 seconds in an airplane. No one could predict either the long-term effects of weightlessness or the results of a sudden return to normal gravity. These biomedical concerns, though interesting in themselves, were part of a larger goal: to use space stations as bases for interplanetary flight. A first-generation laboratory would provide facilities to develop and qualify the various systems, structures, and operational techniques needed for an orbital launch facility or a larger space station. Finally, a manned laboratory had obvious uses in the conduct of scientific research in astronomy, physics, and biology.

Regardless of the value of the science behind this potential project, politics again began to drive program design. George Mueller, who directed NASA's Office of Manned Space Flight during the Apollo Program, led the decision for "all-up" testing of the Saturn V launch vehicle (in lieu of stage-by-stage testing.) Not only did this save time (Mueller actually harbored doubts about whether Apollo would reach the moon by 1969) and money, but it resulted in a surplus of Apollo vehicles which could then be used for other purposes. Mueller was also concerned about NASA's mission beyond Apollo, and worried that any significant hiatus between Apollo and its successor would affect the 400,000 individuals working on the lunar landing program. Thus, the Apollo Applications Program was born: using Apollo hardware, space missions would be developed with an emphasis on space science and would include space stations in earth orbit and long-duration visits to the lunar surface. Funding for this program was slashed by Congress before it could begin, but a single element, a space station, remained. This became the Skylab Program.

Launched in May 1973, *Skylab* hosted three separate crews over the following year; the final crew established an endurance record of 84 continuous days in space. This was the first U.S. space program in which long-duration spaceflight physiologic adaptation and habitability issues could be investigated, and a wealth of data on crew health was collected. Confirmation of space motion sickness was made (initially observed during Apollo), cardiovascular deconditioning was examined in detail and bone loss—particularly in weight-bearing bones—was confirmed; muscle wasting was

seen as well. Much of NASA's knowledge of physiologic effects of long-duration spaceflight was derived from the Skylab program. Despite a multitude of Shuttle flights, including several devoted to space physiology and other life sciences, little unique additional insights beyond the Skylab medical observations have been made in the manned spaceflight program.

Unfortunately, *Skylab* hosted only three crews before its program was discontinued in 1974 and NASA turned its attention to the development of the Space Shuttle, another engineering-driven objective. Just when astronaut healthcare appeared in the spotlight, it was forcefully yanked backstage again. The Shuttle Program has dominated the U.S. human spaceflight program and continues to fly today. The "about-face" from Skylab was again politically-motivated. NASA, lacking a well-defined objective post-Apollo, was keen to set another ambitious goal: a manned mission to Mars. Such a program would include the development of a reusable launch vehicle, and orbiting space station, and a trip to Mars. While NASA was unable to see the entire program to Congress, it did obtain funding for the development of the reusable launch vehicle, the Space Shuttle.

The "mature" status of crew safety and health in the U.S. Manned Spaceflight Program

The Shuttle program was devastated by the loss of the *Challenger* orbiter on January 28, 1986, when a solid rocket booster split open, igniting the fuel inside the large external tank. The program went on hiatus for two years while the accident was thoroughly investigated. While numerous breakdowns in program management were cited, it is particularly disturbing that along with engineering shortcuts and reductions in safety checks, it was revealed that, consequently, the shuttle had no crew egress capability in the event of a shuttle emergency, such as a failure of the Solid Rocket Boosters. As observed in the 1986 *Presidential Commission on the Space Shuttle Challenger Accident Report*: The Shuttle program management considered first-stage abort options and crew escape options several times during the history of the program, but because of limited utility, technical infeasibility, or program cost and schedule, no systems were implemented.

Because of a focus on engineering-related design compromises, the crew's health and safety was also causality. Emergency egress is now part of Shuttle training, but it is sad to note that it took the loss of seven astronauts to implement these procedures. Again, when NASA gets sloppy, astronaut lives are lost.

NASA has been relatively fortunate to have "cheated death" on several occasions when it made the decision to send volunteer astronauts to the Mir Space Station in the mid-1990's in order to gain long-duration spaceflight experience in anticipation of the completion of the International Space Station. Six astronauts spent time on the *Mir*, gaining valuable—and sometimes harrowing—experience with long-duration flight. Astronaut John Blaha experienced a bout of depression during his stay, and Norm Thagard also reported feelings of cultural and social isolation. Jerry Linnenger survived a fire on board the station, and Michael Foale endured a spacecraft collision with *Mir* and subsequent station depressurization. Many of the astronauts and flight surgeons assigned to monitor them complained that NASA was unaware of the dangers facing them on *Mir*.

We are now in the age of the International Space Station, which began construction in 1998. The ISS was intended to carry seven crew members from the U.S., Russia, the European Space Agency, and Japan. One of the major objectives for the ISS has been to continue to develop countermeasures necessary for interplanetary travel. Unfortunately, due to significant cost overruns, the ISS currently subsists with a three-member crew, who spend the majority of their time maintaining the station, rather than conducting research in a variety of disciplines, including medical. Moreover, budgetary constraints have resulted in the cancellation of the Crew Return Vehicle, which would return crew members to earth in the event of an emergency (normal procedure calls for crew return via the Shuttle). In its place, a Russian *Soyuz* spacecraft remains docked to the ISS. In the event of significant crew injury, however, a return to earth on the *Soyuz* is challenging. Three crew members sit in a fetal position in the spacecraft. There is no way to supply oxygen to injured crew members, much less artificially ventilate them. It also carries limited medical supplies and minimal food. Reentry exposes the crew to high *g*-forces, possibly up to 10-*g*'s, which could be agonizing to an injured crew member. Finally, the *Soyuz* lands in the middle of the Kazakhstan steppe and may require prolonged search and recovery of the spacecraft. Due to the obvious limitations presented by a return to earth in the *Soyuz* (not to men-

tion the associated costs, currently at $500M), NASA is beginning to embrace a "stand and fight" approach to medical care on the ISS, with crew return only when absolutely necessary. This emerging stance regarding medical care is likely to be accelerated out of necessity following the *Columbia* tragedy, as ISS crews will be relying on *Soyuz* transport to and from the orbit at least for the short-term.

A vision for the future?

Eventually, NASA and other world space programs hope to send humans back to the moon, and then, ultimately, to Mars. These basic destinations have not changed in the dawn of the "space race." However, despite our knowledge of space physiology, we have yet to develop the countermeasures to mitigate many of the effects of microgravity, particularly bone loss and muscle wasting. These countermeasures may significantly impact the success of a mission into deep space. This is a staggering realization in light of the fact that we have been flying into space for over 40 years!

For the past several years, researchers at NASA have outlined medical areas of concern in a project known as the *Critical Path Roadmap: Human Exploration and Development of Space* (criticalpath.jsc.nasa.gov). This project has been tasked with defining a strategy for assessing, understanding, mitigating and managing the risks associated with long-duration spaceflight. Several areas of research have been identified, including the highest priority areas of bone loss, psychosocial interactions/crew selection, immune function, and other chronic effects of high-energy radiation exposure, including cancer. These areas of research complement programs being run through the National Space Biomedical Research Institute (NSBRI.org), which partners with NASA on the research and development of spaceflight countermeasures. It is hoped that in the next two decades, effective countermeasures for the highest priority medical issues will be devised. While this partnership appears to be logical on paper, in reality many researchers have complained that the organizations are too closely associated and that there is little interest in sharing information with the wider scientific community, which would provide a broader peer-review base and possibly a more diverse and creative point-of-view.

Other current issues with astronaut healthcare and safety

Several other challenges exist in the current NASA system that compound the difficulties with astronaut healthcare and safety. From various conversations these authors have had with individuals involved with astronaut healthcare at Johnson Space Center, it is interesting to note that flight surgeons are currently assigned "one to each mission crew." The flight surgeon conditions the crew into regarding him/her as "their private physician." While this may help to foster a greater level of trust between that individual flight surgeon and his/her crew, other problems arise as a consequence of this exclusive relationship. For example, crew have been reluctant to listen to medical advice while in orbit from any flight surgeon other than their "own." Moreover, flight surgeons themselves, in an effort to preserve their individual relationships with assigned crew, are frequently unwilling to make changes to healthcare regimens and prefer to defer to the assigned physician to a particular crew. In the event of a major crew medical event while in space, this deference to the assigned crew flight surgeon could present safety concerns when medical action is rapidly required, as it may be imperative to heed the direction with whomever is sitting on flight surgeon console in Mission Control.

In addition to the challenges of practice within the flight surgeon ranks at NASA, our contacts have also related that there is little opportunity for other healthcare practitioners to provide medical advisement to the flight surgeons. For example, NASA's primary life sciences contractor, Wyle Life Sciences, has established a clinical pharmacy position to work at Johnson Space Center. Nevertheless, this individual has little influence on flight surgeon prescribing for astronauts. Nursing staff does not collaborate routinely with the flight surgeons on crew medical care issues, either. In traditional hospital practice, collaborative practice among a variety of healthcare practitioners has been associated with improved patient outcomes; it is logical to assume that a similar collaborative practice would benefit astronaut healthcare and safety.

Most astronauts are not trained healthcare practitioners. This poses significant limitations on the potential for healthcare delivery in space. On the ISS, for example, the "stand and fight" position NASA is now embracing regarding medical events is sobering in light of this lack of training among astronauts.

Finally, the reliance of NASA for partnering with independent contractors creates its own set of

frustrations. In recruiting for their clinical pharmacist position, Wyle Laboratories severely underestimated salary requirements for prospective employees, which clearly limited their pool of candidates for this position. Inability to attract (and retain) talent can also impact the quality of healthcare delivered to the astronauts.

Is NASA doing anything right?

It would seem that NASA's longstanding record with regards to astronaut healthcare and safety leaves little hope that there are some things that they are "doing right." Nevertheless, there are indications that NASA is trying to become more progressive with regards to astronaut healthcare. The following are two notable programs that the authors of this paper have been involved in:

1. Integrated Project Teams (IPTs) In the last few years, NASA has made attempts to outreach and network with individuals outside usual NASA contacts. At Johnson Space Center, for example, IPTs were created in with the intent to serve as discipline-specific advisory panels for key operational and clinical issues related to astronaut health, performance, and safety before, during, and after spaceflight. For example, one of these teams, the Nutrition and Clinical Care IPT, was assembled by the Pharmacotherapeutics Laboratory to provide external review for issues regarding medication use in space. Three significant recommendations of this group resulted in positive enhancements to astronaut care:

a. Hiring of a clinical pharmacist- the IPT strongly endorsed the creation of a clinical pharmacy position to enhance the clinical care contributions of the Pharmacotherapeutics Laboratory, which was previously concentrated solely on medication research. Wyle Laboratories created the position, which has been expanded to two full-time pharmacists.

b. Medication monographs for the Shuttle and ISS- another strong endorsement came for the development of standardized monographs that would provide essential drug information to both flight surgeons and astronauts. The newly-hired clinical pharmacist was assigned responsibility for the creation of these materials. Two members of the IPT, a clinical pharmacist and a nurse practitioner, remain involved in content creation, review and updates.

c. Drug stability in space-early discussions within the IPT generated significant concern over the possibility that medications traveling into space to either the Shuttle or ISS could be prone to accelerated break-down (due to lack of refrigeration, increased exposure to radiation, etc.) With the backing of the IPT, the Pharmacotherapeutics Laboratory was successful in obtaining funding for a project to assess drug stability in space. Initial results were recently presented at a research conference, and were reported online at space.com:

Together, the study team evaluated the stability of drugs flown on ten consecutive shuttle flights and five International Space Station sojourns. Ten candidate drugs — dispensed in tablet, suppository, cream, ointment, and patch form — were selected for testing before and after they were flown on one or more space flights. Medications selected included antibiotics and motion sickness formulations. These pharmaceuticals were checked for stability, shelf life, as well as physical appearance, chemical content and dissolution rate - how well the medicine dissolves.

Results from ground-control samples and those from flight were compared to assess stability and shelf life claimed on the label. The team found, of the drugs tested, "significant degradation" of chemical content in Augmentin (a treatment for respiratory infections) and Bactrim (an antibacterial combination drug). Furthermore, other medicines flown in space showed decreased chemical content, or a lessened ability to dissolve. Also found by the researchers were drug dosage forms not significantly different from their corresponding ground controls.

2. Patient Condition Database™ In an effort to gather the best medical knowledge on treatment of specific medical conditions that might occur on the ISS, Wyle Laboratories and NASA have begun the creation of a Patient Condition Database (PCDB)™ , a collection of 450 medical events most likely to occur on ISS, along with recommendations for optimal care. Data on care has been collected from the literature and expert opinion from a diverse group of healthcare practitioners, including flight surgeons, non-NASA physicians (primary care and emergency medicine disciplines), clinical pharmacy, and nursing. The team leading this project also convened a Pharmacology Summit recently to review the medications currently flown on the ISS in an effort to streamline the list and to ensure that the best therapeutic

options were being carried. Several of the healthcare practitioners involved in this project continue to be routinely contacted for input on evolving medication issues.

Are there additional improvements to astronaut healthcare and safety that can be initiated by NASA?

In addition to the positive programmatic examples outlined above, there are many other opportunities for improving NASA's ability to ensure the health of its astronauts. Two "blue ribbon panels" have produced a number of thoughtful and important recommendations to NASA. The Space Studies Board of the National Research Council has produced two reports on NASA's life sciences programs that have attempted to set priorities for research. These reports included human spaceflight under the larger life sciences research umbrella. The last report, *A Strategy for Research in Space Biology and Medicine in the New Century*, published in 1998, also expressed:

> …significant concerns [regarding NASA's] …program and policy arena… These concerns [relate] to strategic planning and conduct of space-based research; utilization of the International Space Station for life sciences research; mechanisms for promoting integrated and interdisciplinary research; collection of and access to human flight data; publication of and access to space life sciences research in general; and professional [outreach] and education.[21]

Many of the issues identified by the Space Studies Board relative to astronaut health appeared to persist when the Institute of Medicine published *Safe Passage: Astronaut Care for Exploration Missions* in 2001. This report, which was commissioned by NASA, was tasked with making recommendations for a space-based healthcare infrastructure, including identifying the clinical and health services research necessary to implement such a system and defining a standard of care for astronauts potentially traveling into deep space.

Conclusion 1

Space travel is inherently hazardous. The risks to human health of long-duration missions beyond Earth Orbit, if not solved, represent the greatest challenge to human exploration of deep space. The development of solutions is complicated by lack of a full understanding of the nature of the risks and their fundamental causes.

The unique environment of deep space presents challenges that are both qualitatively and quantitatively different from those encountered in Earth's orbit. Risks are compounded by the impossibility of a timely return to Earth and of easy resupply and by the greatly altered communications with Earth

The successes of short-duration space missions may have led to misunderstanding of the true risks of space travel by the public. Public understanding is necessary both for support of long-duration missions and in the event of a catastrophe.

Conclusion 2

Crew health has not received the attention that it must receive to ensure the safety of astronauts on long-duration missions beyond Earth orbit; NASA has not sufficiently integrated astronaut healthcare into mission operations.

Currently, there is no comprehensive and inclusive strategy to provide optimum healthcare for astronauts in support of long-duration missions beyond Earth's orbit, nor is there sufficient coordination of healthcare needs with the engineering aspects of such missions.

An effective healthcare system is founded on data that are accumulated, analyzed, and used to continuously improve healthcare for astronauts on future space missions. Inherent in an appropriate healthcare system is a mechanism that can be used to gather and analyze data relevant to key variables. NASA could have collected and analyzed many more medical data had a comprehensive healthcare system focused on astronauts been in place and been given the priority and resources that it needed.

Although the equipment and expertise that will be needed to provide healthcare during future long-duration missions beyond Earth's orbit cannot be reliably predicted, a healthcare system that is data driven and linked to a research strategy will position NASA to better monitor pertinent developments and meet future challenges.

Conclusion 3

NASA has devoted insufficient resources to developing and assessing the fundamental clinical information necessary for the safety of humans on long-duration missions beyond Earth's orbit.

Although humans have flown in space for nearly four decades, a paucity of useful clinical data have been collected and analyzed. The reasons for this include inadequate funding; competing mission priorities; and insufficient attention to research, analysis including insufficient investigator access to data and biological samples, and the

scientific method.

Although NASA's current approach to addressing healthcare issues through the use of engineering design and countermeasures has been successful for short-duration missions, deep space is a unique environment that requires a different approach.

A major problem of space medicine research is the small number of astronaut research participants, which requires special design and analysis of the data from clinical trials with small numbers of participants. This necessitates a strategy focused on maximization of opportunities for learning.

Conclusion 4

Behavioral health and performance effectiveness present major challenges to the success of missions that involve quantum increases in the time and distances traveled beyond Earth's orbit.

The available evidence-based spaceflight data are insufficient to make an objective evaluation or projection regarding the behavioral health issues that are likely to arise.

The analysis of the complex individual and group habitability interactions that critically influence behavioral health and performance effectiveness in the course of long-duration missions remains to be planned and undertaken.

There is a need for more information about support delivery systems at the interface between ground-based and space-dwelling groups.

In the absence of a valid and reliable analysis of existing database, it is not possible to determine whether the current procedures will be adequate for screening and selection of candidates for long duration missions.

Although the data from natural analog environments, including simulation studies, may be helpful, there remains a need to accumulate knowledge based on observation from systematic research in both natural and simulated extreme terrestrial environments and venues like the International Space Station.

Conclusion 5

The ultimate reason for the collection and analysis of astronaut health-related data is to ensure the health and safety of the astronauts.

Emphasis on the confidentiality of the astronaut clinical data has resulted in lost opportunities to understand human physiological adaptations to space, and concern for the protection of privacy and over the implications regarding disclosure and use of clinical data may have led to the underreporting of relevant information.

Reevaluation of the application of the Privacy Act and statutory privacy provisions may be necessary to enable appropriate access to necessary data while protecting the privacy of the individual astronaut.

The unique environment of deep space, combined with the social and institutional contexts of the healthcare research with astronauts, requires that astronauts be considered a unique population of research participants.

A limited international consensus exists on the appropriate principles and procedures for the collection and analysis of astronaut medical data. The potential for conflict among the national space agencies and International Space Station is high.

Conclusion 6

Exploratory missions with humans involves a high degree of human-machine interaction. The human factor will become more important as the durations of missions into deep space with humans increases and as the spacecraft crew functions more autonomously, adapts to unexpected situations, and makes real-time decisions.

NASA, because of its mission and history, has tended to be an insular organization dominated by traditional engineering. Because of the engineering problems associated with early space endeavors, the historical approach to solving problems has been that of engineering. Long duration space travel will require a different approach, one requiring wider participation of those with expertise in divergent, emerging, and evolving fields. NASA has only recently begun to recognize this insufficiency and to reach out to communities, both domestic and international, to gain expertise on how to remedy it.

Engineering and biology are increasingly integrated at NASA, and this integration will be of benefit to the flexibility and control of long-duration missions into deep space. NASA's structure does not, however, easily support the rapidly advancing integration or engineering and biology that is occurring throughout the engineering world outside NASA. NASA does not have a single entity that has authority over all aspects of astronaut health, healthcare, habitability, and safety that could facilitate the integration of astronaut health and healthcare with engineering.

The human being must be integrated into the space mission in the same way in which all other aspects of the mission are integrated. A

comprehensive organizational and functional strategy is needed to coordinate engineering and human needs.

CONCLUSION 7

The challenges to humans who venture beyond Earth's orbit are complex because of both the unique environment that deep space represents and the unsolved engineering and human health problems related to long-duration missions in deep space. The committee believes that the organizational structure of NASA may not be appropriate to successfully meet the challenges of ensuring the health and safety of humans on long-duration missions beyond Earth's orbit.

Astronaut health and performance will be central to the success of long-duration space missions, but the responsibility for astronaut health and performance is buried deep within NASA.

Within NASA the focus on healthcare research and astronaut health is not sufficient, nor does NASA sufficiently coordinate and integrate the research activities needed to support successful long-duration missions beyond Earth's orbit.

It would appear prudent for NASA to take the frank recommendations of the Space Studies Board and the Institute of Medicine seriously; however, it is not yet entirely clear whether these panels will be heeded entirely.

In addition to these recommendations, we offer some additional suggestions of our own:

1. Foster a more productive relationship between medical support and the astronauts The issue of "trust" between astronauts and flight surgeons has been an issue since the beginnings of manned spaceflight, but assigning one flight surgeon per crew is not the answer. Crew should be conditioned to consider the flight surgeons as a "team"—a collaborative practice—and that any of the physicians can provide medical care to them during a mission. NASA should also encourage a shift in mindset of the astronauts: admission of medical problems may not unilaterally result in grounding (educating the crew on those conditions which would result in grounding may be helpful in encouraging a more open dialogue between astronauts and flight surgeons); revealing health issues, particularly while in space, may help provide important information that could lead to the development of countermeasures that could benefit future astronauts.

2. Encouraging collaborative healthcare In addition to flight surgeons, NASA should be encouraged to expand the healthcare team to include, minimally, nurses and clinical pharmacists. These additional practitioners can bring a complimentary view to astronaut health management and may also help in fostering trust among the astronauts; crew may feel more comfortable relaying health information to a nurse, for example. Should NASA seriously consider hiring these personnel, it must also carefully consider optimizing salary and benefits in order to be competitive with the private sector. Moreover, such positions should reside within NASA, not within the jurisdiction of a subcontractor.

3. Removing barriers to information exchange We agree with the Institute of Medicine that NASA has traditionally been an "insular organization". Because of NASA's reliance on Congressional budgetary approval, it has become routine for the agency to portray an "all systems nominal" façade; thus, admission that astronaut health and safety may not be optimal would pose a risk to funding (however, if NASA did lay forth the case that funding was needed to ensure astronaut health and safety because of specific issues laid forth to Congress, would not additional funding be provided due to political pressure from this enhanced honesty?) If one takes a broader view, NASA's unwillingness to share information with external researchers and consultants limits the infiltration of new ideas, updated healthcare information, and alternative points of view. Firstly, NASA should change its policies regarding the strict confidentiality rules it has self-imposed regarding release of astronaut medical information. This will require a shift in astronaut attitude regarding the prudent sharing of medical information; while appropriate blinding of identity of information should be assured as much as possible, sharing of medical information with a broader group of researchers may reveal insights that the limited view of the flight surgeons could not see. Secondly, NASA should commit itself to the wider sharing of healthcare research with the more general medical community. A focused effort to publish in peer-reviewed journals whose readership falls into general practice and submission of abstracts for presentation at large medical conferences (physician, nursing, pharmacy and other allied health professional

meetings) will help in raising awareness and interest among those who traditionally may not have considered astronaut healthcare. In addition, NASA and its affiliate organizations should make a greater effort to advertise for their own healthcare conferences. For example, NASA holds biannual Space Human Factors and Bioastronautics Investigator's Workshops. These meetings offer all NASA-funded life sciences investigators the opportunity to present their work. These meetings are great opportunities to learn about astronaut healthcare issues and afford the opportunity to speak with the primary researchers. It is not generally known that non-researchers can also attend these meetings. For more information see: *http://www.dsls.usra.edu/dsls/meetings.html*. Finally, serious consideration to fostering collaboration with other spacefaring groups such as the Space Nursing Society, the Mars Society and the National Space Society, should also be considered, as these groups all have a vested interest in ensuring astronaut health as means to the end of increasing the number of laypersons who may someday safely travel into space.

4. Consider recruitment of more "healthcare professional" astronauts While some physicians have been recruited, the majority of astronauts do not possess a healthcare background. In the event of a significant medical event, particularly on the ISS, where NASA has adopted a "stand and fight" policy regarding healthcare, effective treatment could be significantly compromised, despite the best efforts of the ground and the provision of adequate medical supplies. Just as NASA made the decision to begin to recruit "astronaut scientists" in the 1960's to round out the lunar exploration program, perhaps it is time to seriously consider increasing the number of healthcare professional astronauts (e.g. physicians, nurse practitioners, and possibly other healthcare professionals, such as paramedics.) Ideally, each ISS crew should have one healthcare professional astronaut per expedition. The need for healthcare professional astronauts will be even more critical should we eventually commit to a Mars mission, as communication time delays will necessitate greater crew autonomy (and thus less reliance on ground flight surgeon support.)

5. "Human engineering" If NASA is truly committed to ensuring astronaut health and safety, it should seriously consider a fundamental change in how it views astronauts. As NASA remains an engineering-focused enterprise, we propose that healthcare should become regarded as "human engineering". Thus, the purpose of the flight surgeons and other healthcare professionals is to maintain the "human machine" for spaceflight operations. By using the common engineering "language" to characterize the astronauts as "complex machinery that must be maintained", it is possible that a greater appreciation for the need for healthcare will be realized by the dominant engineering constituents within the organization.

Finally, it may be time to seriously consider redefining NASA's purpose altogether. As long as NASA remains a government-sponsored entity, it will be dependent on garnering Congressional support for funding. Thus, policy will continue to be dictated by short-term political agendas and reshuffling prioritization—and healthcare (and safety) will remain in the queue behind larger, engineering-driven objectives. As an article in *the Economist* recently suggested, perhaps a shift in NASA's purpose should be redefined to determining enabling technologies (which would include healthcare and safety countermeasures) to allow space travel to be opened up to a wider audience:

> The only good reason for NASA to be involved in human spaceflight is to lay the ground for opening space up for everybody. It takes a vast leap of imagination to detect this reason in NASA's present strategy. Fleeting visits to the moon (or, one day, to Mars) would turn the agency into little more than an elite travel agent. But for decades there has been a huge pent-up demand for flights into space. Although the private sector is finally making some progress towards this, NASA should have been there years ago… Space, like the Wild West, can be truly opened up only by the private sector. NASA's central goal in human space flight should be to make that possible.

With space pundits calling for NASA to define a new sense of purpose in the wake of the *Columbia* disaster, perhaps truly embracing an "enabling" philosophy will finally provide NASA with the direction it needs—and the healthcare prioritization that its astronauts (and future spacefarers) deserve.

Reasons to Believe

By Tammy Ruggles

What does the public want from NASA? And what do they believe is our destiny in space?

"We should always look to the unknown places for answers and awareness of our universe. The cure for cancer, diabetes, and all other diseases may lie in the deepest, darkest places of space."—J. Rice.

Mr. Rice works with at-risk families for the state of Kentucky and enjoys politics, sports, and folk music. He has a reason to believe that our space program is valuable, and that the cure for disease can lie beyond our globe. He speaks from the deepest place in his heart: His mother died of cancer only a few years ago.

A family-focused widow in her seventies, Mrs. Rice left the worst—her suffering…….and the best—her children—behind.

Mr. Rice is keenly aware that our space program has made advances in medicine and cancer treatment that allowed his mother a longer life than what would have been possible even ten years ago.

But it wasn't enough. And he won't be satisfied until cancer is a foreign and forgotten word.

Sandra L has a reason to believe that our space program is valuable, and that life-saving medicines and cancer-fighting treatments should be pursued with a vengeance. She was an active, productive, small-town hair stylist and grandmother in her fifties until breast cancer came to claim her in 2001. Though she has had a mastectomy and is fighting an aggressive form of the disease, she has not given up life or hope. Thanks to the biomedical accomplishments made possible via space technology, she enjoys a more positive body image and confident outlook today.

Her cancer treatment has been successful to date, even though she has been warned that the cancer could return. She can't lift her arms to style hair like she once did, but she is thankful to have a second chance at living, loving, and doing.

There are degrees of awareness of what our space program is all about. Some know surprisingly little, and others know surprisingly much. One rural home school teacher, Ms. L, gives this comment: "If the media would spend as much time and money promoting our space program as they do promoting sports and celebrities, the whole world would be amazed at what it does. But what we usually see is a five-minute tag at the end of a news broadcast. It's not enough. Teachers have a limited amount of time. Children don't read like they used to. Unfortunately they get most of their information from TV. The space program should do more PR. They do a lot, but the message doesn't seem to be getting out. Ask a kid who Michael Jordan is, they'll tell you. Ask them who John Glenn is, you get a blank stare. It's not the teachers' fault. Maybe it's the space program's? At any rate, the space program should be more involved in tooting its own horn. It takes the spotlight when there's a disaster, and that's a shame, because there is so much more the public should be seeing and hearing about it. NASA should produce a weekly TV show, like they do with nature shows. I bet they would get a lot more support, both financially and emotionally, if they did this. It would give kids other heroes to admire besides TV wrestlers. People don't see the connection between "the universe out there", and their everyday lives. TV could be a bridge between the two. Our kids idolize sports figures and celebrities. It's time for kids to idolize math, science, and technology. Some say our nation falls behind academically when compared to other countries. Some say we are ahead technologically. We need to ask ourselves what the truth is, and we need to ask why."

There is a wide range of support too. The younger generation appears to show the most support, but some healthy skepticism too:

Sara F, a high school student who earned a scholarship to college, doesn't hesitate when it comes to voicing her opinion. "The space program is necessary for research and technology. We have to be on the cutting edge of developments in many areas, and the space program is the arena in which to do this in. The people who say it's too costly just don't understand all that the space program has given us, and will continue to give us in the future. Many "spin offs" have come from technology

developed in the space program, like pacemakers, microwaves, tanning beds, x ray technology. On the downside, from what I hear from government workers, they do waste money, buy $200 toilet seats, buy a box of nuts and bolts when they only need one, hire people excessively because of their inside connections who don't really serve a purpose. I don't believe the space program should be completely eliminated, but much of the time, effort and money could be better used in more domestic programs."

R. Highfield, a high school graduate and soon-to-be college student, agrees that the space program is vital. Not only to our scientific community, but "to the average person. We use space technology for every day uses, like microwaves. People don't realize that our conveniences are a direct result of space."

S. Sapp, also a high school senior who writes for his school newspaper: "If we cut down on the funding, we'll fall behind. The government wastes a lot of money on programs, but it isn't wasted when it comes to space."

Principals, teachers, and other educational professionals are perhaps the most supportive of the program. They know how vital it is to impart knowledge of our wonders to young minds:

Dr. P. Garcia, Director/superintendent of Metro Nashville Public Schools in Tennessee: "I believe in the space program. Many of the things we use today are the results of years of research and inventions used for the space program. We learn much every day about space, which is applicable to us. I think it would be a serious mistake to reduce funding. There are always going to be unfortunate accidents. Many people die every day jogging, riding bikes or in automobiles, and I do not see anybody trying to eliminate their existence."

Brenda, a teacher's aid from Virginia, believes, "Putting robots into our space shuttles and sending them up to explore would be safer, yes. If a shuttle disaster happened, only robots would be lost, and they can be replaced. Humans can't. But robots aren't exactly the answer either. Can a robot's heart beat faster when it actually steps on the surface of another planet? Can it smile or laugh when it discovers a new star? Can it describe how breathtaking the solar system is? We shouldn't ban all human flight, but we should use robots on every flight. It should be a joint adventure. Computers do a lot for us, but we can't let them think, feel, and dream for us. We can't call them hero."

Older generations are more conservative in their opinions. Their concerns lie more with their fixed incomes, the state of the economy, and the threat of terrorism. But when the question of national defense comes up, **L.H**, a retired farmer and diesel mechanic states, "If going into space can strengthen our national defense with missile systems, then it's a good thing we're going. But the thing is, it can't do anything against car bombs or anthrax poisoning."

J. Hobbs is a foster grandparent in an elementary school who helps young students improve their reading skills. In her mid-eighties, she said, "I think we should make progress, but think the millions of dollars would be better spent on problems like poverty, drug prevention programs, and after school programs. It's good to have such a nice space program, but what good does it do us when our children and future children are faced with more immediate problems?"

The question of spending almost always comes up. **T. Shaw**, a retired bank teller, states, "Though it's expensive, I think we should remain competitive. We can't allow other nations and societies to surpass us and develop these medical breakthroughs. If we're going to find cures for diseases, then the United States needs to be the ones to do it first."

C. Fannin, a hairdresser and mother of a high school honor student, says, "I know the space program takes a lot of money, and receives a lot of money, but I know, just like any other government program, there is a lot of waste going on. Safety of the astronauts should be their first priority. That's where most of the money should go. If they put human beings on those space flights, then mishaps should not be a problem. Not with all the money available for safety."

Asked how much they would pay to find a cure for cancer and other diseases, and the answer is always the same: Whatever it takes.

Some people aren't enthusiastic at all when it comes to our space program. An Indiana contractor says, "I don't like spending all that money on it, because what do I personally get out of it? If they found a cure for cancer, do you really think they would tell us? The medical industries make their money off of sick people. NASA is just a way to keep a bunch of government employees on the payroll. Yeah, it's science and all, but what good does space do us if you can't put food on your own table? Why should I care about their salary when they don't care about mine?"

Stan, a pizzeria operator from Chicago is just as vocal: "I work every day. Seven days a week. Why

"The people who say it's too costly just don't understand all that the space program has given us, and will continue to give us in the future."

—A high school student

"I am in awe ***that those people took the risk they did. That's why when I hear or read something about space, I listen or read a little closer. Those astronauts died for the sake of progress and exploration."***

—A car salesman from San Diego

should I care what goes on in space? I got enough worries right here on planet earth."

"I don't know enough about it to comment," **Lois**, a fitness trainer from Alabama and single mother of four says. "But I know when there's a waste of money and when there's not. If the space program wants to help me out, maybe pay my bills or buy my health insurance, sure, I'll send them a donation now and then."

Larry, a computer repairman from Georgia, says, "It's not that I don't support it or agree with it. It's just that when you prioritize your life, it doesn't seem that important. Sorry. That's just the way it is. Tell you the truth, though, I'd rather support the space program than some TV evangelist who's going to take my money and put it in his pocket. At least with the space projects, you can see where the money is going."

"Sometimes I wonder what makes us look out there instead of at each other," an insurance salesman from Minnesota states. "Dreamers I guess. Astronomers. Scientists. It takes all kinds to make us the technological giant we are. As long as we take care of each other down here, I don't care what they do in outer space."

"We're going to have a space program no matter what I say," says a shoe store owner from Kansas. "If I could vote on it come Election Day, I'd vote no. It's not that I'd want to stop progress. I'd want to stop the wasting of money. Can't we have a space program for less money?"

Francis, a dairy farmer from Ohio, says, "I can think of worse things to spend money on: Welfare, abortions, grants, government studies that don't mean anything."

Jessica C, a factory worker in Kentucky: "I think it's a waste of money, but as a kid I wanted to go to a space camp. I do know that they do a lot for kids."

Others take a humorous approach. **T. Riley** works with a trucking company in Ohio and likes to hunt and four-wheel in his spare time. He said, "I'm all for space exploration. As long as it doesn't lead to any alien abductions or probes!"

"I know zilch", declares **Travis R.**

T.J. a high school student: "We put people in space, but we can't put a car on the road that runs on water! No kidding. I'd like to see us inventing new kinds of transportation, fuels, and more. Like space stations where you can go to live. Or finding life on another planet. Vitamins that make you live longer. Stuff to clean up our air and water. Jet packs that let you fly. Science fiction is turning into science fact."

The opinions are as varied and colorful as our solar system itself.

Even the most strident opponent concedes that we should never dismantle or diminish our space program if it compromises medical research.

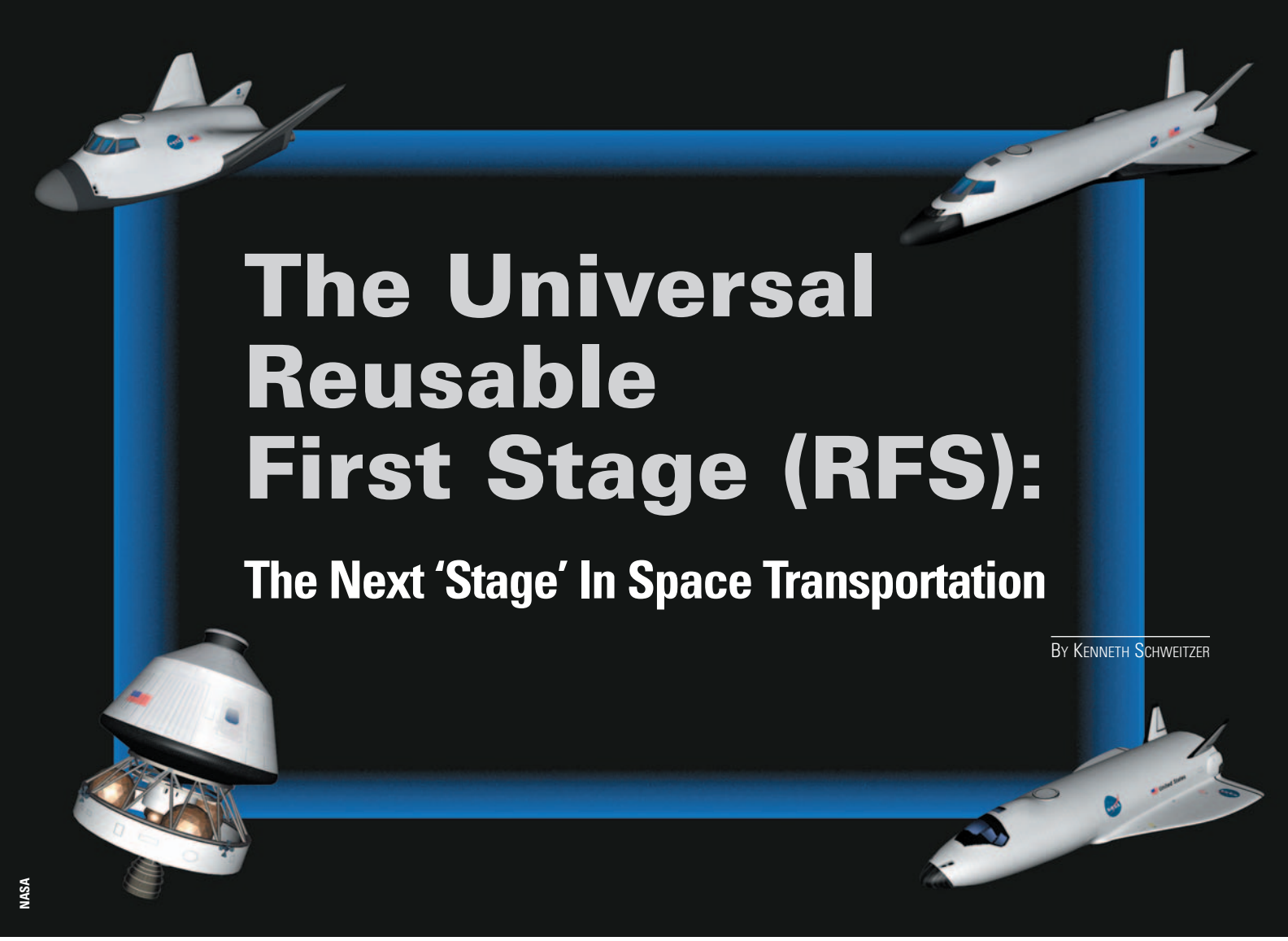
Whatever it takes.

Most people don't go out looking for information on the space program. It's something they don't think about until it's brought to their attention, usually via television.

"I hate to say it," **Bob**, a substance abuse counselor from Florida explains, "but when I go buy something to read or visit the library, I don't normally go for the science magazines. It's not that I'm not interested. It's just that I don't understand it. It's way over my head. But if someone can explain to me in layman's terms what they're doing in space research, I appreciate it. Sometimes it seems like only the scientific community can understand what's going on."

A car salesman from San Diego had this to say about the space shuttle Columbia tragedy: "I am in awe that those people took the risk they did. That's why when I hear or read something about space, I listen or read a little closer. Those astronauts died for the sake of progress and exploration. It makes you pay closer attention. It did me anyway. I don't understand the tech side of things. Just the human. And losing them was a real loss for our country."

A young stay-at-home mother from Iowa says that she can't remember a time when she didn't have a science or science fiction book lying around the house: "It's just something I'm drawn to. I'm not a scientist, or a researcher, or an astronomer, or an astronaut. But there's something about us always learning more about the universe that fascinates me. Call it God, or Creation, or whatever you want to. I think we are meant to explore everything. We are curious creatures. I think God made us that way for a reason. If we don't do new things and see new places, we wouldn't have all the advances we have today. We'd be a dead civilization. I hope one day my son and daughter will want to be a part of the space program. I won't be living in a space station, but maybe they will, or their grandchildren will. Maybe they'll find cures and come up with new life-extending medicines. Or find answers to our pollution problems, and our environmental problems. I know the space program is working on those answers right now. Maybe my kids will join them and keep everyone's dreams alive."



The Universal Reusable First Stage (RFS):

The Next 'Stage' In Space Transportation

By Kenneth Schweitzer

NASA

Concepts for a variety of orbital vehicles capable of being launched by a Universal RFS.

The Space Race of the 1960s did not allow the time needed to develop reusable Space transportation systems. The requirement to beat the Russians led to the development of expendable capsules: the Mercury, Gemini, and Apollo spacecraft. Reusable hardware in most applications offers cost savings over 'one use' expendable hardware. This of course is only true if the given hardware is planned on being used or operated many times. If it is not, then 'one time' or few use hardware is more cost-effective for a given application, as engineering and production costs are greater when designing for reusable systems.

Reusable First Stage (RFS) Defined

As you probably know there are many different rocket designs being flown around the world. They are common to each other in that they all use multiple expendable rocket 'stages' in their designs. Since the 1960s and through today, every rocket has used expendable first stages. Once the stage has completed its job of accelerating the other stages and its payload to a specified height and speed, it is discarded where it breaks up and sinks to the bottom of an ocean. A combination of immature technology along with funding limitations has led to the delay in the introduction of more reliable and cost-effective reusable rocket designs.

The RFS acts like a traditional expendable first stage during its initial launch until separation occurs. After the RFS booster has depleted its fuel, it performs a jet-powered return to a runway. A rocket stage such as this that can be refurbished and reused again many times offers significant cost savings. In addition, a powered flyback stage offers inherent safety margins for the vehicle.

RFS and the Shuttle

Following the Space Race, the country's focus fell back to the logical course of developing a reusable Space transportation system, the Space Shuttle we use today. For the lowest possible operating costs, a fully reusable vehicle was preferred. The original Space Shuttle design consisted of two reusable stages. A reusable flyback first stage and a second reusable stage composed of the orbital vehicle.

Lockheed Martin

A Universal RFS returns to a soft runway landing after successfully helping to boost a commercial RLV to orbit.

Budget cuts by the Nixon Administration nixed that promising design. After the Challenger disaster in 1986, the RFS gained more interest and supporters but was never able to receive the funding necessary to proceed. The Shuttle we use today utilizes what some people would call a reusable first stage system. The solid rocket boosters (SRBs) the Shuttle employs however are costly, dangerous, and have to be 'rebuilt' after each use. The ocean's salty waters causes corrosion to the boosters and the process of inspecting each booster after being pulled from the ocean and brought back to land for refueling is an arduous process.

The mid-to late 1990s saw NASA give Lockheed Martin and Boeing, the builders and operators of the Space Shuttle, small amounts of money to further design flyback boosters tailored for the Shuttle system as part of a possible upgrade program if it would be determined that the Shuttle would be flying for another twenty years. In this event, the reusable boosters would replace the Shuttle's current SRBs. The boosters would separate from the orbiter and external tank (ET) at around 31 miles (50 kilometers) and then land at a runway.

Originally the Space Shuttle system was to have a RFS and fly some 60 times a year. If we were to design and build an RFS today exclusively for the Space Shuttle, it would not be cost effective given today's Shuttle flight rates of 4 to 6 flights a year. Of course the uncertainty over how future operations of the Shuttle will proceed from here after the Columbia tragedy only adds to the unlikelihood of a Shuttle exclusive RFS ever being developed. NASA in the past five years estimated it would cost a minimum of $5 billion to bring 3 or 4 pairs of RFS boosters to operational status for the Shuttle, with the potential to save perhaps a few hundred million dollars per year in Shuttle launch costs given an average flight rate of at least 6 flights a year. This would mean it would take some 10 to 15 years of flying the Shuttle to just breakeven on the investment. Soon after the Shuttle would have to be retired anyways, leaving no new cost savings.

The cost analysis alone means the RFS has to be designed from the start to be universal, able to be applied to multiple vehicle concepts.

The Universal RFS

Not only can a RFS replace the Shuttle's SRBs, but an appropriately designed 'universal' RFS will be able to launch a variety of different second-stage, or 'upper-stage' vehicles. The government-funded RFS will become the first stage for a host of launch vehicles and spacecraft. It will provide the first stage of a government-developed heavy lift launch vehicle (HLLV) for human missions to the Moon and Mars as well as other heavy payloads. This vehicle will likely incorporate many Shuttle elements such as the ET and perhaps the Shuttle's main engines, providing a low development/operating cost heavy lifter for government payloads. More importantly, the government-funded and developed RFS, too costly for commercial companies to develop on their own, will provide the 'boost' needed for the next generation of commercial Space 'shuttles' in the next decade.

This government investment enables the development of the next generation of specialized orbital spacecraft to be developed by small companies and entrepreneurs much more easily than would otherwise be possible as the companies would need to only develop their respective designs for the actual spacecraft, the orbital vehicle, rather than wasting time and money developing the expensive launch vehicle, or booster stage themselves. This will enable a large number of spacecraft designs and competitors in the human Space transport industry, and hence lower costs for everyone, as a variety of orbital 'spaceplanes' take to the skies.

The realization following the Columbia tragedy that the country needs more than a single means to transport humans to Space, allows this new opportunity to appropriately fund and build the RFS demonstrator to accommodate multiple vehicle designs by the end of the decade.

International Efforts

American rocket scientists aren't the only ones that see a RFS as an appropriate evolutionary step in Space transportation. In particular, the European Space countries and Russia, have detailed designs for such a system for their respective launch vehicles.

Named the Baikal, the first stage of a new two-stage Russian rocket called Angara, the Russian flyback booster will rocket to about 38 miles (60 kilometers) before a second stage with payload separates for the final lift to orbit. After separation the main booster deploys a pair of wings and a jet engine fires up to return the flyback booster (s) to a runway landing.

In February of this year, Europe and Russia signed an agreement to expand their cooperation on developing new launch vehicle technologies. With Russian Soyuz launchers getting ready to be launched from the French Guiana launch complex, and the Baikal designed and ready to be developed pending funding, it appears that European Space

Agency funding for a RFS booster for both Russian and European launch vehicles is in the making. In fact, the French Guiana launch complex may become the launch site for Russia's new generation of Angara launch vehicles.

The Entrepreneurs

Reusable hardware for launch vehicles is such a logical next step that Space entrepreneurs have and continue to plan for such stages in their rocket designs. Beal Aerospace, a small rocket upstart from 1996-2000, intended on developing a RFS for its own line of rockets. More recently SpaceX, a launch company started by entrepreneur Elon Musk, aims to develop a two-stage launch vehicle consisting of a RFS. Starcraft Boosters Corporation has been advocating RFS boosters for the past few years. In 2002, the company received funding from the Air Force to proceed with the development of a small reusable technology demonstrator based on the company's designs.

RFS Today

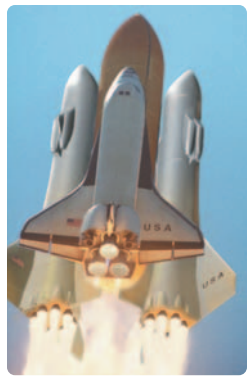
Studies have continued recently on RFS designs and systems under NASA's Space Launch Initiative program in the past two years. The Orbital Space Plane program, or 'mini-shuttle', which is now being accelerated, or at least fully funded following the loss of Columbia, is being designed to be able to be launched via a RFS.

Starcraft Booster's small development program was the start of the first real effort to develop a full scale RFS system, as actual hardware was built. Following this successful program a larger scaled size demonstrator will likely receive funding, building upon the experience gained from these early test flights.

At least an 80% scale test vehicle is required for this type of development program in order for the demonstrators test results to be 'traceable' in technology, operations, and subsystems to a full-scale operational vehicle. Such a demonstrator can be flying by the end of the decade.

Eventually as many as a dozen of these new boosters will make up a fleet of first-stage boosters for a variety of new commercially developed and operated orbital spacecraft that will follow the suborbital reusable launch vehicle market in the next decade.

The RFS for new Space transportation systems is the next 'stage' in Space transportation. After decades of studies, it looks as if its time has finally arrived!



Lockheed Martin

The Universal RFS boosts the Space Shuttle into orbit on one of its final missions to the International Space Station.

2003 Washington Legislative Conference Report

BY CLIFFORD R. MCMURRAY

On the warm spring afternoon of Sunday, April 6, a determined band of space activists met at the Westin Grand Hotel in Washington D.C. to begin their training as volunteer Congressional lobbyists for the first annual NSS Legislative Conference. They came from all across the country (one NSS member from as far away as England) to communicate directly with their elected representatives on the issues affecting American space policy in this watershed year. The loss of space shuttle Columbia only two months earlier lent added urgency to their mission: to tell their Representatives and Senators how important space is to our future.

To take the best advantage of that opportunity, the participants at the conference spent Sunday afternoon and Monday morning in training on how to make effective presentations to Congressional offices and listening to briefings from Washington insiders that gave them valuable background information on space policy. Mr. McMurray gave a presentation on basic Congressional protocol. NSS Board member Mark Hopkins and David Schuman, both experienced in the ways of Washington, gave a couple of humorous demonstrations of how and how not to make a positive impression when paying a visit to a Congressman's office. Participants were cautioned that the people they would be talking to in the upcoming days would have varying levels of interest and education in space issues, from people whose level of enthusiasm matched their own to people actively hostile to the idea of "wasting money in space."

The meat of the discussion on Sunday afternoon centered around the briefing package prepared by the NSS Policy Committee The briefing packet identified three broad areas of policy to be addressed: 1) Make space access as inexpensive, robust, and reliable as possible, 2) Develop a long-term space exploration architecture to provide a clear direction for the future, and 3) Ensure government policy does not inhibit market forces and potential private sector opportunities. Within each of these broader policy concepts, NSS has specific budget and legislative recommendations.

NSS Legislative Conference attendees in 2325 RHOB.

NSS Executive Director Brian Chase stressed that the purpose of these visits to Congress was not just to tell the Representatives and Senators what we think, but to collect intelligence about what they think—whether they support space exploration and commercialization or not, and which programs they like and dislike. "This is just the start of our conversation with these offices," Chase said. "The intelligence we get this year will shape our approach to individual representatives in years to come." For each office visit, a debriefing form was provided to collect information that will go into a new NSS legislative database.

On Monday morning, the volunteer lobbyists reconvened in the House Science Committee conference room in the Rayburn House Office Building. Briefings were conducted by

CNSS Vice President and Board Member Greg Allison delivers NSS petitions to U.S. Senator Saxby Chambliss (R-GA).

Mark Hopkins (left) and Bradley Krake (right) with U.S. Representative Brad Sherman (D-CA).

Brendan Curry (Senior Legislative Assistant for Congressman Dave Weldon), Lee Arnold (Legislative Counsel for Congressman Tom Feeney), Paul Piscopo (a senior official in the Department of Defense Office of Defense Research and Engineering and Staff Director for the recently concluded Commission on the Future of the U.S. Aerospace Industry), and Scott Pace (former NSS Board member and current NASA Deputy Chief of Staff). Mr. Curry and Mr. Arnold spoke about the current concerns of House members with respect to space policy. Both stressed the need for NASA to move forward with developing and flying the Orbital Space Plane as soon as possible, so NASA could keep flying even if the Shuttle were to be grounded again in the future. Mr. Piscopo talked about the National Aerospace Initiative, an effort by the Department of Defense to produce fundamental technology breakthroughs in the field of hypersonic flight; this will have significant impact on the development of the next generation of reusable launch vehicles. Mr. Pace discussed NASA's current view of its mission and its plans for implementing that mission, focusing on a robotic/human partnership that will eventually extend beyond low earth orbit and out into the solar system.

After a quick lunch, the volunteers were ready to "hit the Hill" with their first series of office visits. Tuesday morning the volunteers compared experiences on the Hill the day before returning for more visits.

By 5 PM on Tuesday, the Congressional office visits had been concluded, and the teams met in the cafeteria of the Rayburn House Office Building to finish up the paperwork, and a promise to see each other next year. Everyone agreed that they had learned a thing or two, and had a lot of fun along the way.

A total of nearly 80 offices were visited by the NSS volunteer lobbyists this year, with another 20 requesting information, resulting in contact with nearly 100 offices in a 48 hour period of time. We hope you will plan join us in Washington next spring for the second annual NSS Washington Legislative Conference, and add your voice to the voices of other activists!

I Want To Go

By Eric Anderson, President and CEO, Space Adventures, Ltd.

In the immediate wake of Columbia's loss, the International Space Station partner nations agreed to set aside all available near-term seats on Soyuz spacecraft to deliver Expedition crews to the ISS. For Space Adventures and for space tourism, this suspension of "taxi" missions meant, at least for a while, there would be no extra seats available for commercial use. The proverbial "ball" Space Adventures had started rolling with the flights of our clients Dennis Tito and Mark Shuttleworth in 2001 and 2002 came to halt. Of course, it was the right thing to do at the time and Space Adventures expressed in communications to our Russian partners and NASA our support.

During the weeks following, we formulated a plan to restart space tourism; but in doing so, a hesitation emerged: Do tourists have a place participating in an activity as risky as space flight?

The business of flying of well-trained and privately funded astronauts and cosmonauts ("space tourism") is of critical importance to the lasting and continuous exploration and development of space. Space tourism is the only near-term market that can profitably support the development of drastically less expensive and substantially safer space vehicles, for the simple reason that making space flight orders of magnitude safer and less expensive is directly correlated to increasing the frequency at which it is accomplished. Under the current government flight schedule of four to five shuttle missions (after return to flight) and two Soyuz launches per year, there is no way we a flight rate of thousands or tens of thousands per year can be reached. Only the demand for space tourism provides such an impetus, and as a society we must support all space flight opportunities, be they suborbital or orbital to the ISS, government or commercial, in order to create a world in which space is truly available.

Space tourism is not just one way, but it is the best way, for the rest of us to ensure that space is explored and developed in our lifetimes. The dreams we share of opening the space frontier to the masses will not occur if space flight remains an activity limited to a handful of government agencies.

At Space Adventures we took a significant step forward on June 18th, with our acquisition of the first private mission to the ISS. This mission and the others that will follow will fly additional private explorers on extra Soyuz flights, opening several new seats annually.

And now, a call to action - it is time to remind the world how many of us want to fly. We reside in every community, every city, and in every nation of the world. We invite you to proudly declare with us, "I want to go!" Your support of space tourism will bring the day closer when we accomplish our goal of living and working in space, and perhaps most poignantly, will serve as a lasting legacy for those who have given their lives to pursue the dream we all share – when we live and work in space for the benefit of all.

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The NSS Chapter List is available at **http://www.nss.org/chapter.** Please direct all changes to NSS Headquarters at nsshq@nss.org.

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The Human Journey

By Brian E. Chase, NSS Executive Director

I hope you had a chance to read this issue's column by Eric Anderson of Space Adventures. His op-ed focuses on an announcement that RSA has agreed to resume flying Soyuz flights with paying tourists to the International Space Station, with the first such launch in 2005 after the Space Shuttle has resumed flights and ISS supplies and logistics are back to normal.

So what makes this announcement remarkable? These Soyuz flights will be 100% dedicated to tourism, with two paying customers on each flight, instead of only one. This is good news for everyone involved, including Russia, the United States, and all ISS partner nations, because it gives Russia additional revenue to continue Soyuz production, and if the demand is high enough to manifest multiple private Soyuz launches, those capsules could become a supplemental part of the supply chain needed to support ISS.

This announcement also highlights the importance of the private sector efforts to build a space access infrastructure. Yet some of the most exciting and promising developments in this area are occurring in companies that aren't even planning to reach orbit with the vehicles currently in development. Instead, these efforts are aimed at achieving suborbital altitudes.

But even as they tackle the financial and technical challenges to achieve their objective, some of the biggest hurdles they face are government regulations. Suborbital launches do not fit into the existing descriptions of either aircraft or spacecraft, so the federal regulatory structure is struggling to develop ways to handle (i.e. regulate) this new breed of vehicle. NSS will be taking an active role to help these companies overcome this hurdle and help the government understand the importance of their efforts. Let the success or failure of these efforts rest on their merits, not because of the limitations imposed by government bureaucracy.

Brian E. Chase

The long term prospects of the suborbital launch sector in many ways can reshape the way we approach the exploration and development of space. If even one of the more than twenty teams competing for the X-Prize are successful, that has the potential to spawn a huge "near-space" tourism market (see Futron's recent ASCENT report at *www.futron.com*), which in turn will build the business base needed for investment in new orbital launch systems. Unlike past efforts to build new launch vehicles, at least some of these teams have the very real potential to be successful, and in doing so fundamentally change the space industry. I advise you to closely watch these vastly underestimated suborbital launch efforts—they may fundamentally change the way we approach space transportation.

The lesson for all of us, whether we're talking about the resumption of Soyuz tourist flights or the ongoing efforts in the suborbital launch sector, is to ensure free market forces can work within the space business sector. While government funding of many missions will remain critical for decades to come, we must ensure government policies and regulations don't inhibit private sector solutions. Democratic capitalism has built successful nations around the globe, and we shouldn't ignore its potential in overcoming our most pressing barriers to exploring, developing, and settling space.

Ad Astra!

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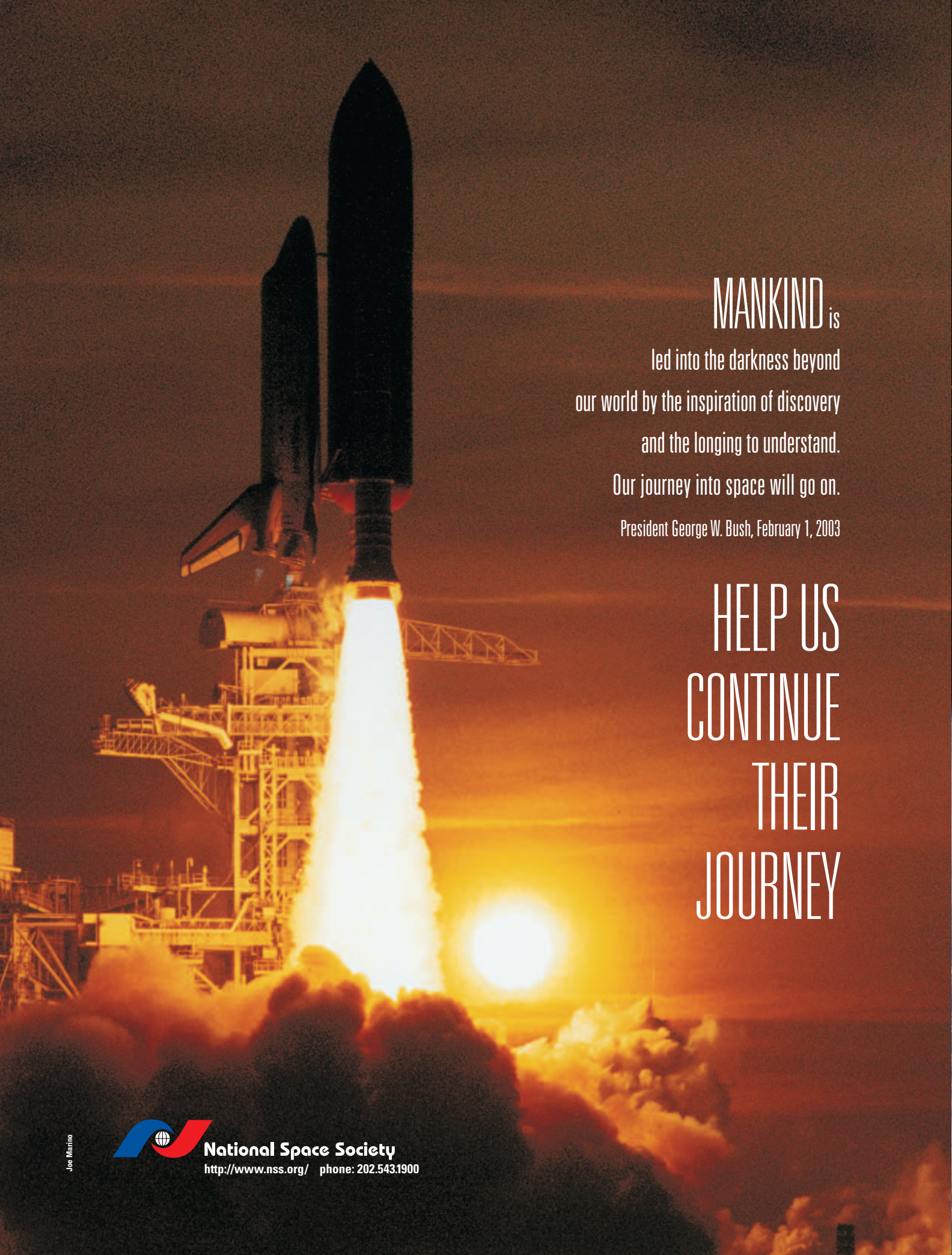
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