SPACE TIMES

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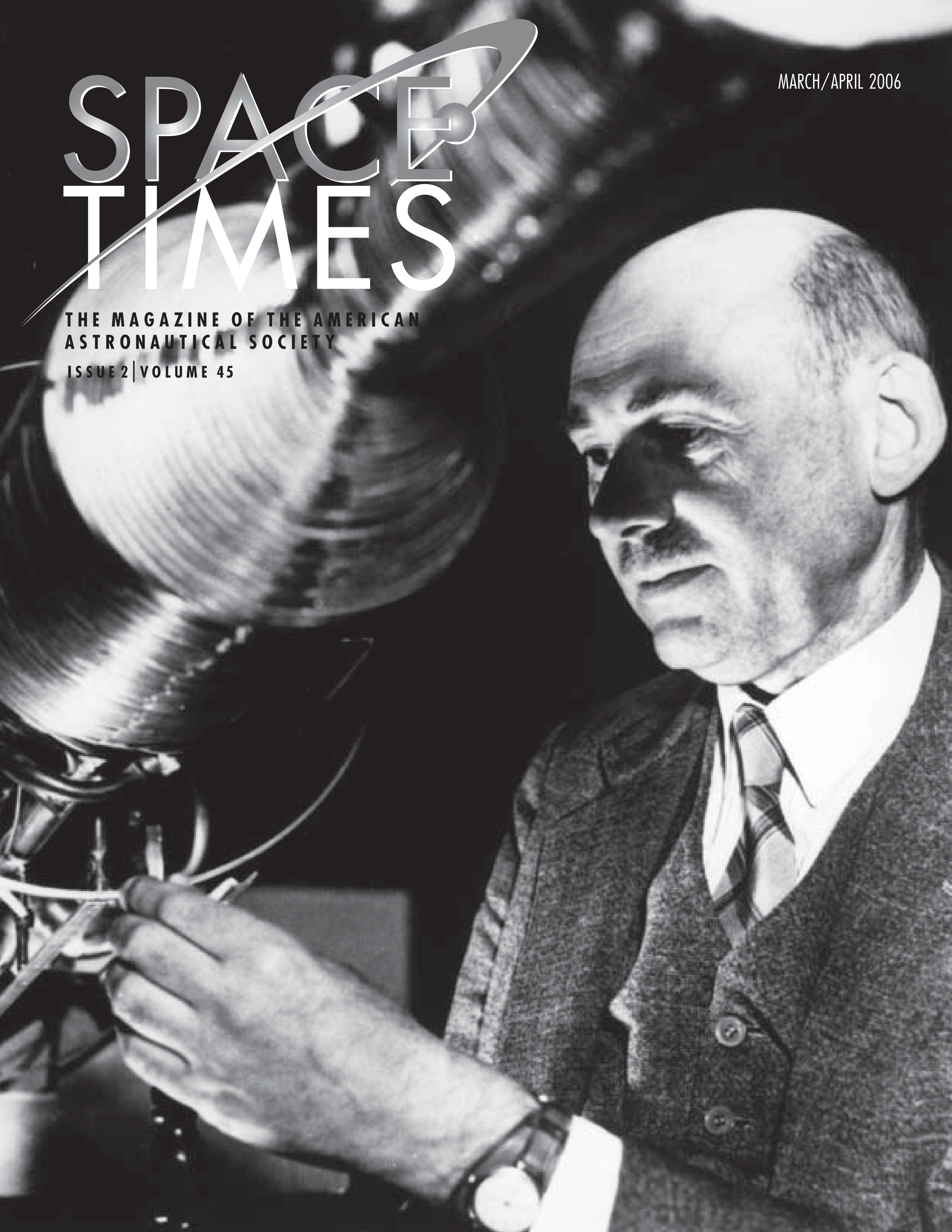
MARCH/APRIL 2006



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American Astronautical Society
6352 Rolling Mill Place, Suite 102
Springfield, VA 22152-2354 U.S.A.
Phone: 703-866-0020 Fax: 703-866-3526
aas@astronautical.org www.astronautical.org

President's Message

What is the AAS? My previous Message described our Society's Strategic Plan, its attributes and content, and progress made toward its implementation in 2005. Strategy exists, after all, to be implemented, to prioritize and align our effort to have maximum impact. In this Message I would like to explore the Strategy's foundation, a foundation that hopefully articulates why you are a member of the AAS and that energizes you to become more involved.

The AAS Strategic Plan, to be effective, must be based on an understanding of who we are, where we hope to go, and the difference we will strive to make. Your Board's Executive Committee (ExComm) and its Strategic Plan Sub-Committee had many long and penetrating discussions on these subjects in the course of developing the Plan. The views, perspective and advice of many members were sought. Fundamental truths and powerful insights emerged from these discussions that, taken together, are the foundation of the Plan:

- **We are a network.** A network, not simply an organization. Time and again we heard of how members had learned, grown, contributed and enriched their careers through relationships with other members, both informally and formally in various AAS activities.

- **We are space professionals, technical and non-technical.** We are space professionals, beyond being space enthusiasts or advocates. We are both technical and non-technical. Our members are engineers, scientists, teachers, astronauts, lawyers, historians, artists, policy analysts, journalists, and entrepreneurs. We are much richer for this mix.

- **We are dedicated solely to space.** Its exploration, use and development. AAS is "Advancing All Space."

- **We are dedicated to harnessing the energy and capability of our members.** We were created by the founders of space exploration over 50 years ago to make a difference. They made a difference. Our members today make a difference. The AAS exists to harness the energy and capabilities of its members to make a difference - to help the people, the profession and the enterprise of space exploration and development flourish.

This foundation is powerful. It differentiates us from other institutes, societies and organizations; it reminds us of our heritage; and it challenges us to rise to our unique potential.

I look forward to sharing strategic progress with you in the coming months and to getting your feedback and ideas.

Mark Craig
mark.k.craig@saic.com

ON THE COVER

The Robert H. Goddard Memorial Symposium is named in honor of the American rocket pioneer. Goddard's numerous patents and technical writings on the development and use of rocketry for space exploration remain the foundation of the discipline to this day and a source of inspiration for all explorers. (Source: NASA)

From the Editor

It's been a fascinating and rewarding couple of months getting up to speed as editor of *Space Times*. This magazine is the popular voice of the American Astronautical Society. As such, it speaks for, and to, the thousands of professionals and observers who have a vested interest in promoting the goals and objectives of AAS; namely, the advancement of all space and the creation of the spacefaring civilization.

For years, I have valued the authority, experience, insight, and, most importantly, passion that the contributors to *Space Times* bring to their work. These pages have played host to articles from countless aerospace luminaries on a truly staggering array of issues. Technology. Policy. Business. Law. Pop culture. History. In the future, you can expect to see this tradition carried forward with more articles, more features, and more special issues designed to keep you up-to-date on the latest thinking in the field.

Space Times is also the magazine of record for AAS, the nation's premier organization dedicated to the principle that individuals and groups sharing both commitment and common cause can create a future in space for generations to come. As such, you, the reader, expect the latest reports from recent AAS events as well as information on upcoming activities of interest to you and your peers in the aerospace community.

Space Times is *your* magazine. As a reader of *Space Times*, you have joined a network of thousands of others who, like you, have a vested interest in the broader goals of the AAS. That network is strong. It grows even stronger when individuals can step up and share their strengths, their talents, and their experience with others on the network. I invite everyone to review the Article Submission Guidelines on page twenty-three and, if you have an interesting story to tell that would benefit the community, let me know.

The goal of *Space Times* has been, and will continue to be, to provide a discussion forum for the community that is anchored in the goals of AAS. It is my responsibility to ensure that *Space Times* continues to serve your needs as your source for thought-provoking insights and the latest developments in this fast and rapidly accelerating field.

Thank you all for this opportunity to serve!

Jonathan M. Krezel
jonathan.krezel@gmail.com

AAS Volunteers Needed

Your help is requested! Three important committees will meet this summer, and each is critical to the work of AAS. The awards committee reviews nominations for ten major AAS annual awards and selects worthy candidates for election by the Board. The Fellows committee reviews candidates for the annual Fellows election; 415 distinguished men and women have been chosen for this honor since 1954. Finally, the nominations committee develops a slate of officer and director candidates for election by the membership. Although the AAS president selects the committee chairs, membership of each is open to AAS members. If you are interested in serving as a committee member, please contact the AAS office at aas@astronautical.org.

Once Upon a Time, "Responsive Space" Was Real — and Needs to be Again

Today we are lucky if "student payloads" are launched before "the student" retires from industry. This can, and must, change by returning to the space program as it once was and making Responsive Space a reality.

by James Wertz

Spaceflight On Demand

As commercials keep reminding us, it is an "on-demand world," unless you're in the business of space. In our line of work, everything takes far longer than it should and longer than it used to take. From the time President Kennedy announced a decision to go to the Moon for the first time, it took eight years to accomplish that remarkable feat. Now we are trying to repeat that goal with an initial timeline that is twice as long and very likely to slip, as all space programs seem to do.

Responsive Space is the process of changing that pattern; i.e., of going back to the way space used to be done when it was more fun, more exciting, cheaper, and got more done. There is no general agreement on just what Responsive Space means. The defining characteristics that I've used for several years are shown in Table 1. The bottom line is that to be responsive, space systems have to be many times faster to get into space and quite a few times cheaper than has been the case for a long time.

Why Be in Such a Hurry?

When Hurricanes Katrina and later Rita hit the gulf coast, we needed information, we needed communications, we needed better data for forecasts, and we needed them in hours, not months or years. It has become clear to all of us that both natural and man-made disasters can wipe out much of the infrastructure on which we have come to depend, and saving lives and property depends in part on restoring services (and getting new ones in place) in a very short time.

Imagine what might have occurred if we could have launched a satellite within hours of the Southeast Asia tsunami and seen where large debris fields had been washed out to sea. It is at least possible that many who died might have been saved. I cannot prove that better knowledge or better communications or better forecasting would have saved lives in either Southeast Asia or the U.S. Gulf Coast, but surely most of us can agree that the response that did occur was inadequate to the task at hand.

Similarly, in today's military conflicts, needs change rapidly. Even the location of the battlefield can change in a matter of hours as we fight a truly global war where the enemy can strike anywhere on Earth at any time. Responsive Space can meet this challenge with supplementary communications, surveillance, and weather data available in a matter of hours, providing the right information where and when we need it.

Responsive Space changes the way space assets are used. Today, we take a dramatically long time (and large amounts of money) to build space assets that will last for a decade or more and are fundamentally global in their character and coverage. Since we don't know where the next need will occur, we have to blanket the Earth with all of the information gathering resources. The goal of

- **Responsive** – Provide requested information within 24 hours of an identified need
  - Launch within 8 hours of a previously unknown need
  - Within 2 hours if on alert on the pad
  - Can be put in place before or during a disaster
- **Low Cost** – Total mission cost less than $20 million each
  - Launch = $5 million
  - Spacecraft bus = $5 million
  - Payload = $9 million
  - Operations (6 months) = $1 million
- **Flexible** – Provide multiple types of data (from different spacecraft) for any location on Earth at any specified future time
- **Focused** – Specific geographic location and specific time of day
- **Short Duration** – 6 months to 1 year planned mission life
- **Small Spacecraft** – Total mass less than about 500 lbs
- **Single Function** – 1, or at most 2, payloads per spacecraft
- **Low Altitude Orbit** – 150 to 300 km altitude

Table 1. The defining characteristics of Responsive Space.

Figure 1. Microcosm's Sprite Small Launch Vehicle is intended to launch 810 lbs into low Earth orbit for a total cost of $4.2 million within eight hours of a newly identified demand. This is the type of capability needed to create Responsive Space. (Source: Microcosm)

Responsive Space is to make a more intelligent, focused use of scarce resources that are able to respond in near real time. If we can put assets in place rapidly and at moderate cost, we can do far more with less money. Space assets are certainly not cheap, but then neither is putting a military or civilian task force into a previously unidentified part of the world with an assignment that can change in a matter of days or hours. In addition, using ground or air assets can potentially put personnel in harms way and can be viewed as a hostile act, irrespective of our intentions.

If we can create low-cost, responsive space, there are also a variety of new application areas that may open up. Some of these include:

- Search and rescue for both civilian and military disasters
- Monitoring unfolding world events for news organizations
- Launching student experiments while they're still students
- Follow-up on either successful or unsuccessful science or engineering experiments with new or revised instruments
- Materials processing in space
- Ground-based, rather than space-based sparing for constellations
- Resupply or maintenance missions in case of problems with human spaceflight

Another, often overlooked, reason for Responsive Space is to allow us to take advantage of technological advances in the shortest possible time. As the terrorist threat evolves, so too does our capacity to monitor it, counter it, and to track terrorists and their activities. Unfortunately, traditional space surveillance and reconnaissance systems take years or decades to build and launch. Much lower cost, launch-on-demand satellites can allow us to put new technology into place as soon as it is developed and to try experimental approaches to see if they are effective.

The problem being attacked by Responsive Space is best summed up by several quotes:

"I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to Earth." — John Kennedy, before a joint session of Congress, May 25, 1961

"The U.S. Air Force has kick-started a major study on quick-to-launch boosters capable of enhancing the nation's warfighting abilities,...Given a Pentagon go-ahead and funding, the Air Force could first fly a multi-stage system by 2014." — Leonard David, in *Space News*, March 28, 2003

"If it takes us 11 years to create a Responsive Space capability, we all oughta find a different line of work." — Jim Wertz, Challenge to the First Responsive Space Conference, April 1, 2003.

How Can We Create Responsive Space?

If Responsive Space is critical to the nation, as I believe it is, how do we make it happen? The answer, of course, is that many things have to change — launch systems, payloads, spacecraft, communications, operations, and even the basic way we do business in space.

Although all of the above are important, the most important is launch. While not the dominate element for either cost or timing for most space systems, it nonetheless drives the rest. If we're going to pay $10,000/lb to put things into orbit, and if it takes years to make it happen, then it has to be as light as possible, as efficient as possible, and as error free as possible and this, in turn, makes it take years and cost $10,000/lb.

Fortunately, we can solve this problem. The Soviets and now the Russians have been launching satellites in a day with high reliability and at low cost since very early in the space program. We understand what it takes. Launch vehicles must be designed from the start for responsive launch, and they must be sufficiently low cost to be built to inventory. The launch vehicle must be sitting in storage, ready to go, when the satellite arrives at the gate or when it too is taken out of storage in response to a potentially unforeseen world event, such as the tsunami in Southeast Asia. Microcosm, AirLaunch, SpaceX, and Lockheed-Martin all have launch vehicle designs that can do this job with technology that is essentially available today. (See Figure 1.)

Of course, a responsive launch vehicle is only the first part of the solution. We still need responsive spacecraft, payloads, communications, and operations. There are two basic ways that we can tackle the spacecraft and payload problem. One is to build them up rapidly from large, pre-assembled building blocks. This process has come to be known as the "6-day spacecraft" and quite a bit of work has been done on this approach at the Air Force Research Laboratory and other locations. The other approach is to build full-up satellites in advance and store them in the same fashion that the launch vehicles are stored. When imagery is needed, we take out an imaging satellite, put it on the launch vehicle, and send them both to the launch pad for delivery to orbit. Again, the real key is low cost. If the cost of the complete satellite is less than about $10 million, then it is a reasonable item to keep in inventory, just like cruise missiles, tanks, or material supplies.

The operations problem is a bit trickier because we have to get data down from the satellite after is has gathered that data over a region of the world we hadn't been thinking of as a trouble spot (i.e., southeast Asia) and which may not have the satellite communications infrastructure in place (or may have had it wiped out). Again, there are a number of solutions, including bringing the data down to multiple receivers located at embassies around the world, using satellite communication links (called cross-links), or using store and forward techniques, like the ORBCOMM system, and bring the data back when the satellite next passes over the US.

Ultimately, more than anything else, Responsive Space requires a new way of thinking about how we use space and what we want it to do for us. Certainly there are technical challenges, but these can be overcome with relatively modest amounts of systems engineering and a little old-fashioned ingenuity. The bigger problem is simply deciding to do it, to turn back the clock in a sense to the way the space program was many years ago, and to begin making space once again exciting, economical, and dramatically more relevant to today's world. Changing the entrenched way of doing things is never easy. All of us in the space business are a part of the problem. In the immortal words of Pogo, "We have met the enemy, and he is us." But we can also be a part of the solution. Indeed, we must be, if we are to make space relevant to the problems facing us today and the bringer of promises and dreams to our children and grandchildren as it once was to many of us. ■

***Dr. James Wertz* is the President of Microcosm in El Segundo, CA, and the general chairman and organizer for the annual Responsive Space Conference held in the spring. He is also the editor and a principal author of a number of widely used books in astronautics, including *Space Mission Analysis and Design* and *Reducing Space Mission Cost*.**

INTERNATIONAL SPACE UNIVERSITY

2006 Scholarship Winners

The National Space Society (NSS) and American Astronautical Society are pleased to announce the recipients of their 2006 scholarships to the International Space University (ISU).

For AAS, Kirk Kittell received the $10,000 Lady Mamie Ngan Memorial Scholarship to attend the Summer Session Program. Kirk is pursuing a Masters of Science degree in Aerospace Engineering at the University of Illinois and is an active member of Students for the Exploration and Development of Space (SEDS). Annamarie Askren received the AAS' Annual $3,000 Scholarship to attend the ISU Masters of Space Studies Program. She is a senior at the University of Washington with a major in Aeronautical and Astronautical Engineering.

For NSS, Dan Andrei Costea was awarded a $10,000 scholarship to attend this year's ISU Summer Session Program in Strasbourg, France. He is currently a student at the International University Bremen, studying electrical engineering and computer science. Dan is Romanian, and was part of the winning team in the 2004 NASA Space Settlement Contest. Additionally, a $2,000 scholarship was awarded to Kirk Kittell.

NSS and AAS are among several organizations offering annual scholarships to ISU. For information on ISU programs, check www.isunet.edu. ■

Making the Most of the International Space Station

The success of the International Space Station program now depends on making wise decisions and overcoming the barriers that stand in the way of full scientific utilization of this unique orbiting research outpost.

by Roger D. Launius

No one envisioned that we would be in the current situation when the space station first emerged on the national agenda in 1984. President Ronald Reagan proudly announced it in the State of the Union Address on January 25, 1984, telling the nation that "America has always been greatest when we dared to be great. We can reach for greatness again. We can follow our dreams to distant stars, living and working in space for peaceful, economic, and scientific gain." More than twenty years later those dreams remain unfulfilled. Although a crew has been aboard since 2000, the International Space Station (ISS) remains incomplete and its promise of utilization virtually nonexistent. Instead of "dreams to distant stars" the space station program has suffered a succession of cost overruns (more than $50 billion spent by the U.S. thus far), technical complexity (connecting the multiple components made around the world together on-orbit), political shortsightedness (annual spending caps on the construction effort, the political decision to place ISS in a 51.6 degrees orbital inclination, and a host of other decisions), and international disagreements (over the use of Soyuz capsules and many other issues).

This early "Power Tower" concept is shown flying over Japan with a Japanese module attached at the nadir. The three major elements that make up the Japanese Experimental Module have been completed and are awaiting Shuttle flights to the ISS in the next few years. (Source: NASA)

The expectation that ISS would become a centerpiece of research in orbit sustained the effort. Some have referred to the operational station as an "NIH in space" from which all manner of bio-technical discoveries might spring. Others have emphasized the station's significance as a laboratory for the physical sciences, with materials processing in microgravity the chief research effort. Still others suggest that human factors research will gain a leap forward because of the work on ISS, simply because data about changes to the bodies of astronauts engaging in long duration spaceflight will expand our base of scientific knowledge. Finally, some contend that ISS offers a platform for greater scientific understanding of the universe, especially about the origins and evolution of the Sun and the planets of this solar system. Those four scientific endeavors—bio-tech research, materials science, human factors, and space science—represent a panoply of scientific opportunities once ballyhooed by advocates of the ISS.

The expectation of path-breaking research on-orbit continues to abound. In 2001 Representative Ralph M. Hall (then Democrat-Texas), speaking at the AAS's Goddard Memorial Symposium, commented that while elements of ISS had been launched and crews placed aboard, he questioned NASA's resolve to utilize this new capability. He challenged NASA, "After all of the taxpayer dollars that have been invested in the Space Station, we will need to ensure that we wind up with the world-class research facility that we have been promised." As an aside to his prepared remarks, Hall added that NASA had better find a way to use the ISS effectively. He said that some astounding scientific discovery should be forthcoming—he specifically mentioned a cure for cancer—or the program could rapidly lose political support.

Astronaut William S. McArthur configures the Microgravity Science Glovebox to prepare for the installation and activation of the Protein Crystal Growth Monitoring by Digital Holographic Microscope (PromISS) experiment on board the ISS in January, 2006. (Source: NASA ISS Program Office)

It looks like this has happened only five years into the new century. Even the NASA administrator has called ISS, along with the Space Shuttle, a "mistake." As reported in a page one story in *USA Today* on September 29, 2005, Mike Griffin said, "It is now commonly accepted that was not the right path,…We are now trying to change the path while doing as little damage as we can." Seemingly, ISS is irrelevant to NASA's task of exploring beyond Earth orbit. But how do we change the path? Does it involve quietly withdrawing the resources necessary to utilize ISS and reprogramming it for other purposes? Does it involve turning ISS over to another entity? Does it involve both of those options and perhaps others?

Perhaps I am overly optimistic, but I like to think that the international consortium overseeing ISS would not allow its capability to be abandoned. I also like to think that the many highly intelligent individuals who make up the space community will find a way out of the current box canyon we seem to have traveled down. On my best days I believe this, at other times I wonder. And sometimes deep melancholia sets in as I ponder possible "nightmare scenarios" in which the United States abandons human spaceflight altogether.

Avoiding any of the "nightmare scenarios" for ISS will require dealing with the factors currently limiting utilization. At a minimum there are four major ones. The first is the problem of space access. With the Space Shuttle fleet grounded for all but one mission since the *Columbia* accident of February 1, 2003, reaching ISS has become a task not without difficulties. The Shuttle provided enormous capability to bring cargo and equipment to ISS, to say nothing of the components for completing it, and offered as much as a 20,000 pound down-mass capability in any return to Earth. Its hiatus means that the crew complement shrunk by one-third and the ability to move experiments and other components to and from ISS is limited to Soyuz capsules and Progress resupply modules. Presumably that problem will abate when Shuttle returns to on-going flights, but with the prospect of the system's retirement in the 2010 time frame a long-term issue looms on the horizon. Efforts to address this are necessary now to ensure that we do not "box" ourselves in and avoid future limitations by making careful Crew Exploration Vehicle (CEV) decisions.

Second, crew time on orbit is another limiting factor, and one closely related to the access issue. Aggressively working to ensure a larger crew aboard ISS, and maximizing their time to support research activities, is a prudent course.

Third, the development of experiments and funding available to conduct them should take a higher priority place than at present. Even understanding the very real limitations of funding for science vis à vis other critical priorities, it is important that NASA make a good-faith effort to make ISS a world-class research facility as it promised for more than two decades.

Finally, there are on-going bureaucratic challenges, some of them relating to international commitments, some domestic that require continuing diligence. At a fundamental level (notwithstanding Ralph Hall's quixotic call for curing cancer), as a nation, as a people, and as a spaceflight community we cannot afford to renege on the promises made since the 1980s. If it is a token effort for the short-term, I am willing to accept a token effort. But to abandon serious efforts to utilize ISS plays into the hands of those who wish to see it fail, and those who advocate a zeroing out of the human spaceflight effort in the United States. *The New York Times* editorialized in November 2001: "in truth, it has never been clear just what science needs to be done on a permanently manned platform in space as opposed to an unmanned platform or an earthbound facility." The positions of such naysayers gain significant credibility when we fail to fulfill our longstanding promises.

> "Seemingly, ISS is irrelevant to NASA's task of exploring beyond Earth orbit. But how do we change the path?"

I believe that if we lean forward with a commitment to ISS utilization, discoveries made on the ISS will encourage the development of a bright future in space. Perhaps even a research park in orbit with ISS as the "anchor" will emerge, accelerating research in a wide spectrum of scientific disciplines. Operations centered on the International Space Station could open space to humans in much the same way that modest government investment on the American frontier forged links between curiosity and commerce, knowledge and a bright future. I hope we will advance ISS utilization and make the investments necessary to ensure a peaceful, productive future for humanity in space. ■

Roger D. Launius is Chair of the Division of Space History at the National Air and Space Museum in Washington, DC.

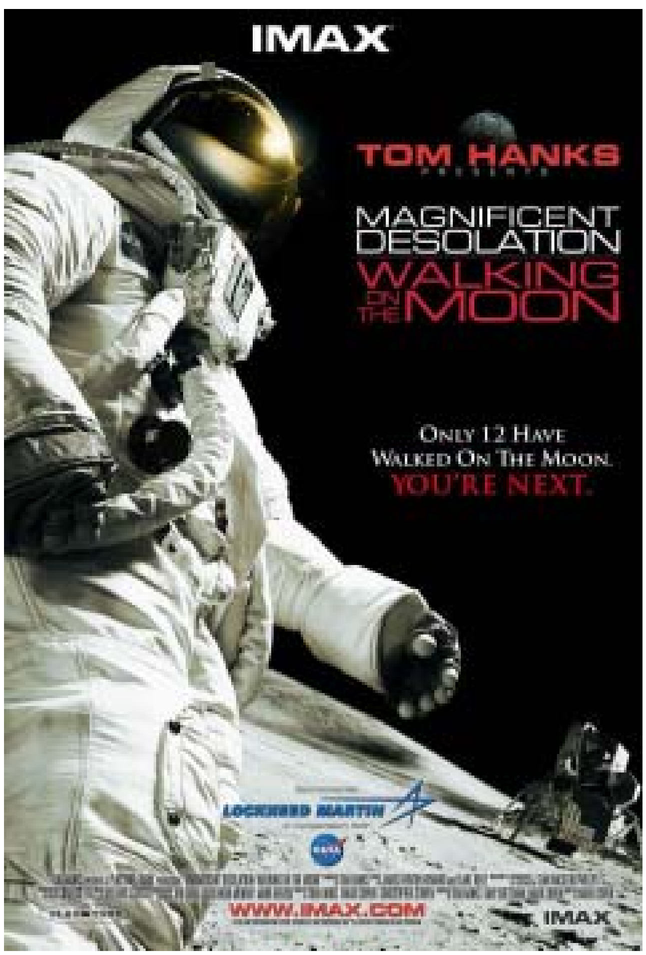
Reviews of *Destination Moon* and *Roving Mars*

Two new IMAX movies demonstrate the power and the challenges of making space films for the REALLY big screen.

by Jonathan M. Krezel

For more than a generation, no technology has brought the visceral excitement of space exploration to more people than the IMAX film. Since the release of the first IMAX movie in 1970, aviation and space films have been a mainstay of the medium, and for obvious reasons. In terms of sheer size, acoustic power, and quality of imagery, nothing compares to watching a movie on these biggest of big screens. Movies like *To Fly!*, *Hail, Columbia!*, *The Dream is Alive*, and *Space Station 3D* have given audiences around the world unprecedented access to and immersion in the thrill of a Space Shuttle launch and the building of the International Space Station. They are the modern equivalent of the old black & white televisions sets that carried the first live images from the lunar surface over thirty-five years ago, and the medium by which huge numbers of people get their first real gut-level taste of what space exploration is really all about.

The latest in this long line of space-themed IMAX shows are now showing nationwide. The first, *Magnificent Desolation: Walking on the Moon 3D*, is an extravagant homage to the Apollo program and our first, tentative forays to the Earth's nearest neighbor. Produced and narrated by veteran Hollywood space enthusiast Tom Hanks, the film is nothing less than a technological marvel. The 3D effects, though still too jarring and clinical at times to be fully lifelike, are nonetheless very compelling and dramatic. The introduction, with a quick, kid-narrated review of mankind's fascination with the moon throughout history, wastes little time in getting the audience into the Lunar Excursion Module and out onto the moon's surface. If anything, the journey happens *too* quickly. For example, you'd expect that an IMAX movie about the Apollo program would have the launch of the gigantic Saturn V – complete with immense clouds of smoke and belching flames accompanied by the unholy roar of five F-1 rocket engines blasting off at full throttle – as its centerpiece. Curiously, *Magnificent Desolation* skips over the launch of an Apollo mission entirely.



Nevertheless, when the audience follows an unspecified Apollo crew to the lunar surface, the spectacle is truly magnificent. We see the moon through the eyes of the astronauts descending the LEM, hear their… *our*…breathing within the spacesuits, feel the dust kicked up as we take our first tentative moonhops over the dusty ground. And when you're on the surface, looking around, you can really *feel* that unearthly loneliness, that sense of wonder bordering on vertigo that one must feel walking in a place that has never, in four and half *billion* years, welcomed another living soul until that very moment.

The most awe-inspiring moment of the whole film may be the shot where the LEM, which fills the whole 365 square meter screen, touches down on the lunar surface on top of a pillar of smoke, fire, and flying lunar rocks.

Then, silence.

The camera, which until now has focused on the LEM and its crew, backs away. And away. And away. What was an imposing interplanetary spacecraft with an intrepid crew of bigger-than-life heroes standing six stories tall, slowly shrinks to nothing more significant that a glittering pinprick of metal swallowed up by the bleak, blasted hills of an utterly alien landscape.

At that moment, you can't help but think that no other movie has ever had a more appropriate name than *Magnificent Desolation.*

Few other formats have the power to just rip this sense of awe straight out of the belly of an audience. At its best, IMAX can do just that. But sometimes the format is so big that it tries to fight the director who tries to tell a more intimate story. *Roving Mars*, the story behind the twin Mars Exploration Rovers *Spirit* and *Opportunity*, doesn't fall into this trap. Whereas the suffocating vastness of the lunar landscape is the star of *Magnificent Desolation*, it's MER Principal Investigator Steve Squires, his team, and two little golf cart-sized robots that steal the show in *Roving Mars*. Squires is a naturally infectious personality with an intense yet folksy demeanor, and his love for his people and the mission easily fill even an IMAX-sized screen. Narrated by actor Paul Newman and with Squires as the tour guide, *Roving Mars* moves effortlessly from the gigantic volcanoes and continent-sized canyons of the Red Planet to the clean rooms at the Jet Propulsion Laboratory in Pasadena, California. Here, the IMAX format is put to work showing the dizzying complexity of the rovers, and the amazing amount of testing and validation needed to bring them to life. Test parachutes rip apart with heart-wrenching sound effects, prototype air bags burst tumbling down rock-strewn ramps in massive wind tunnels, and the whole time the team is pushing, pushing toward a launch schedule dictated by the inviolable laws of Johannes Kepler and Isaac Newton.

Once the rovers are buttoned up in their payload fairings and mounted on top of their Delta II rockets, the full potential of the IMAX theater is unleashed. *Roving Mars* seamlessly blends actual footage from the launch with computer animation. Countdown…5…4…3…2…1. Then…BOOM! The seats rock and roll and the screen explodes as over 1 million pounds of combined thrust flings the rocket off the pad. Nine solid rockets ripple off the bottom of the core booster as their propellant is expended. Then, deafening silence as the first stage is depleted. A few seconds. Then…BOOM! Second stage ignition. More sound and fury as the payload, now traveling at almost 28,000 kilometers per hour, claws its way into orbit. A deafening roar, followed abruptly by quiet as the second stage cuts off. A few seconds. Then…BOOM! Third stage ignition, less than 2% of the thrust of the first stage, and yet the sound coming from the IMAX theater's building-sized speakers is still nearly overwhelming. Finally, engine cutoff, and the rover in its aeroshell is spin-stabilized and ejected for its long nine month cruise. Overall, a fitting start for a mission to the planet named for the Roman god of war…

Even knowing the outcome, the audience seems as tense as the flight controllers at JPL as the rover screams through the Martian atmosphere on descent. Though the movie itself is about robots, the relief and joy of the flight control team when they hear the first tentative signals from their robotic creations safely down on the Martian surface makes *Roving Mars* a seemingly more human film then *Magnificent Desolation*. Afterwards, the science results, including the first compelling evidence of standing liquid water on another planetary surface, seems almost secondary to the sheer thrill of pulling of such gutsy feat.

Together, these films beg a number of questions for the person interested in the long-term exploration and exploitation of space. *Magnificent Desolation* paints a picture of a place as barren as can be imagined. If Apollo was more than the Cold War-era stunt that its detractors claim it to be, then proponents of permanent presence and settlement face the daunting task of explaining how mankind is ready to accept the challenge of transforming such an empty, foreboding landscape into a vibrant focus of scientific and commercial activity in the decades and centuries ahead. The very success with which the movie lives up to its title means that audiences will be left with a powerful sense of how hard that future will be to create.

At the same time, the infusion of humanity into the story of the Mars Exploration Rovers is a powerful reminder that people can indeed connect very deeply to our robotic sentinels on the edge of the unknown. How far can we push that connection and the scientific return from robotic missions before we come to the point where the human element needs to be co-located on site? These are hardly new questions in our community. Nevertheless, the brilliance of these films is their capacity to provoke these questions in a new light…all while taking the audience along for one hell of a wild ride. ■

***Jonathan M. Krezel* is a policy and program analyst at NASA and editor of *Space Times*.**

The Vortex-Cooled Chamber Wall Engine: A Tamed Tornado

Designers hope a new rocket engine technology, combined with new vehicle designs and operating models, will dramatically reduce the cost of getting bulk goods to space.

by Andrew E. Turner and William H. Knuth

The violent winds within tornadoes are among the most powerful forces on the face of the Earth. The Orbital Technologies Corporation (ORBITEC™) of Madison, WI has discovered a way to harness the forces of a powerful tornado-like vortex flow within a new rocket engine where the chamber walls are protected from the fierce heat of combustion by a vortex flow field.

This tamed tornado exists today as the vortex cooled chamber wall (VCCW) rocket engine and is the focus of a 15-month, million-dollar study contract awarded in June 2005 to an Aerojet-led team including ORBITEC, Space Systems/Loral, and Microcosm. The California Space Authority worked to obtain support for this study through the office of Rep. Anna Eshoo (D-CA), and the funding was derived from efforts of the U.S. Congress and Air Force supporting development of advanced launch vehicles.

As the following drawing illustrates, the vortex engine involves injecting one propellant, in this case the oxidizer, at the base of the chamber in a tangential direction to generate a tornado-like flow. This flow swirls up the wall to the head end. There it spirals inwards to form a second vortex that descends along the centerline. The core vortex mixes and burns with the fuel, which is injected at the head end.

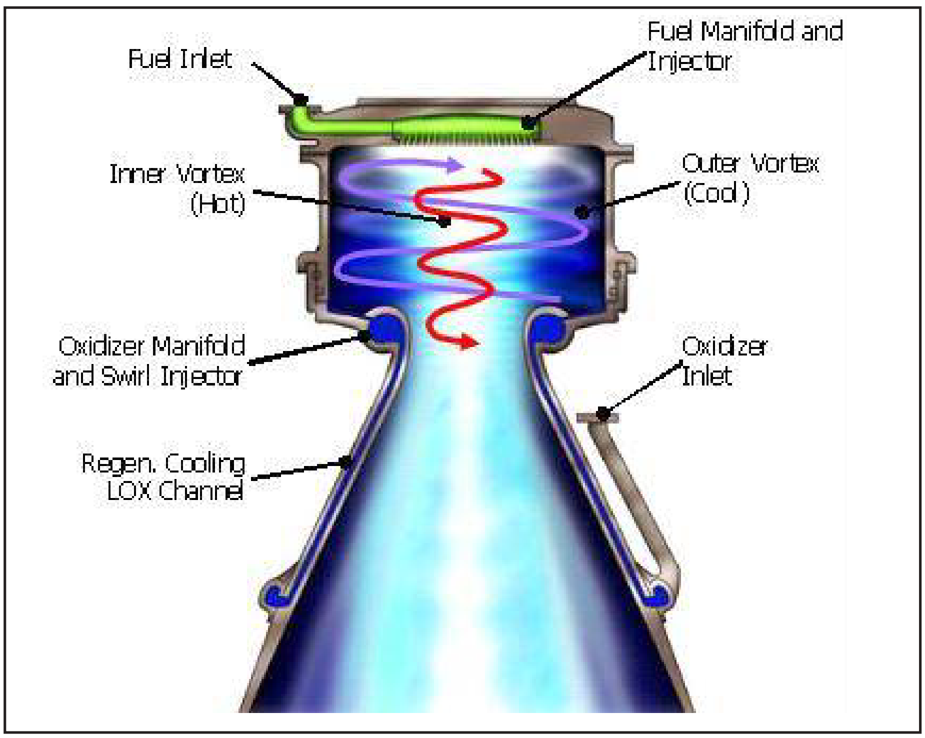
Combustion is confined to the core by vortex-generated dynamic forces. The propellants perform two functions: first one propellant insulates the walls as it works its way to the core. Second, it mixes and burns with the other propellant and releases heat. The result is an exhaust stream of hot, high-pressure gas that produces thrust.

Many rocket engines employ ablative material liners to absorb the heat transferred to the walls, these liners are vaporized and expended in the exhaust. Unfortunately, applying ablatives is costly, particularly in the confined space of the chamber, and adds mass as well. With no ablatives needed in the chamber, the vortex engine promises lower cost and mass, and a shorter schedule.

No mere tempest in a teapot, the vortex engine has already been extensively hot-fire tested. Despite the proverbial warning against wrapping fire in paper, successful results have been obtained using walls of combustible Plexiglas, as the picture shows.

Tests involving a variety of fuels including hydrogen, methane, RP-1 (refined kerosene) and carbon monoxide, with gaseous and liquid oxygen have shown that while the core vortex within the combustion chamber is hot, the chamber walls remain cool. Vortex engines have produced over 386 kilograms of thrust. ORBITEC is currently working on designs for higher thrust levels.

The objective of this new study is to validate the design for a vortex engine with a thrust of 45,000 kilograms or more, the range required for a low-cost launch vehicle. This work begins



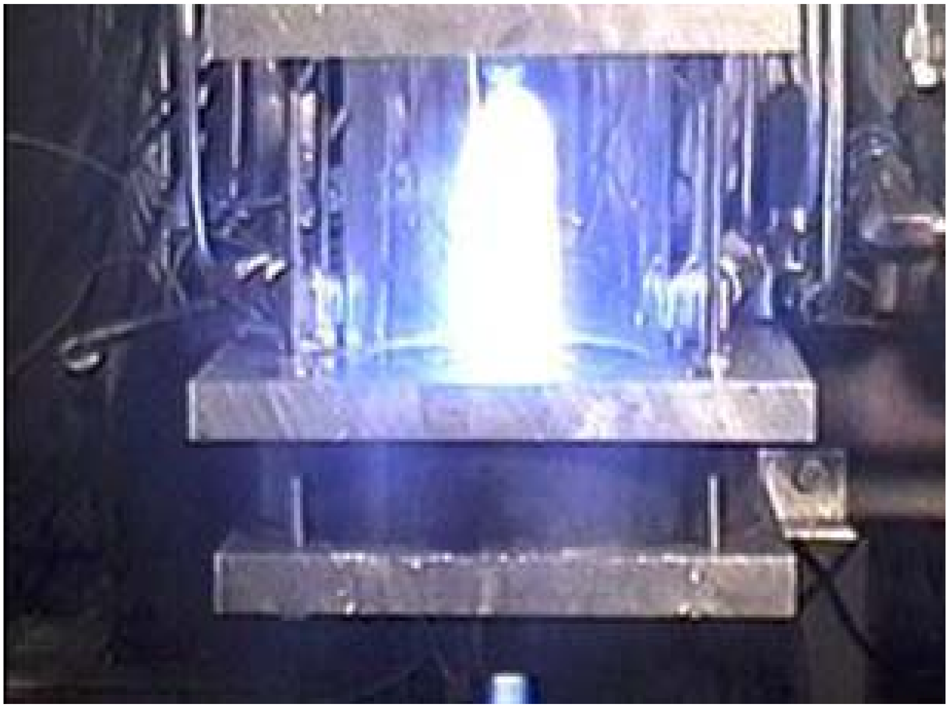
The vortex cooled chamber wall engine contains two co-axial vortices. The oxidizer flowing up from the base forms the outer, insulating vortex, and then spirals in at the head end to form the second vortex that descends to flow out of the engine nozzle. Fuel is injected at the top of this inner combustion vortex. (Source: Orbital Technologies Corporation (ORBITEC™))

with physical testing utilizing cold gas and water flows within highly instrumented large scale engine model. Issues to be resolved include whether this flow can be made to spiral within the vortex core to keep it isolated from the walls even at a large scale where huge quantities of fluid are involved. Can the vortex flow of the combustion gases within the core be expanded into an exhaust jet to efficiently generate thrust at the larger scale? Will the inner and outer vortices remain stable and in a predictable relationship as scale increases? Will additional design features be needed to fully exploit the unique vortex properties and achieve the desired cold wall operation?

The applicability of this new engine is being investigated for a new launch vehicle: Aquarius. The engine and vehicle are well matched from the perspectives of simplicity and economy. For many launchers engine reliability must be close to 100% even if cost is high and schedule tight. As will be discussed, for Aquarius such high engine reliability is not required. Though unlikely, if it were to be found that achievement of high initial reliability of the vortex engine is dependent on an extensive effort, no issue is posed because high reliability is not required for Aquarius economic success.

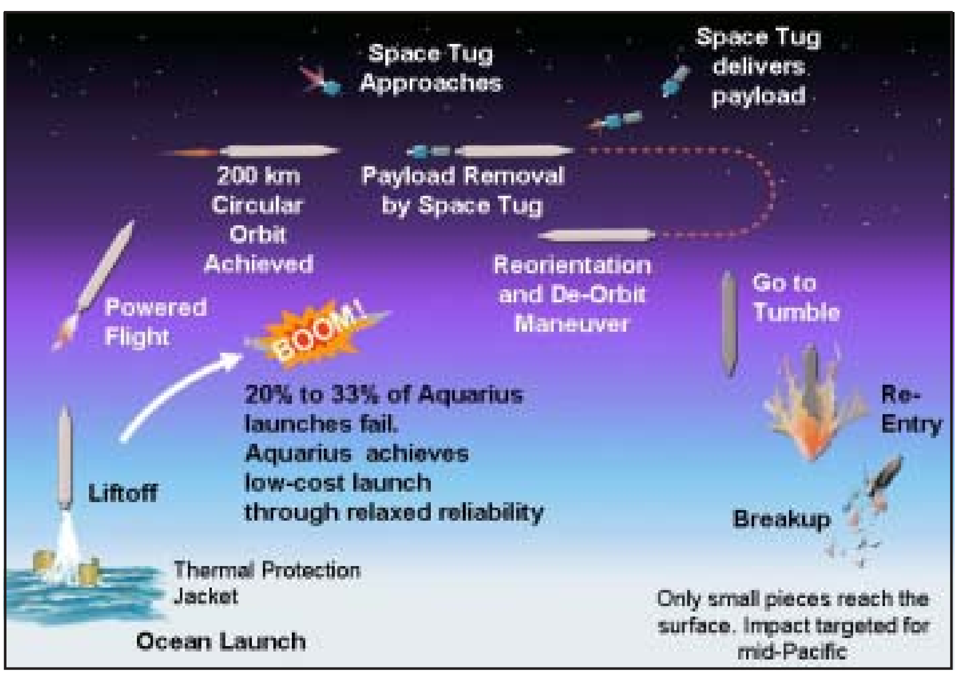
The Aquarius launch vehicle was discussed in a previous article (*Space Times*, May/June 2001), and requires a total liftoff thrust of 400,000 pounds. Here low cost launch is obtained by relaxing reliability. Aquarius system reliability might be only 67%, so engine reliability might be 93%. Aquarius will ship low cost consumables and low-cost, replaceable spacecraft and other equipment to orbit. Since stringent protection of reliability is not required, the cost per pound to orbit could be $500, an order of magnitude below that of any present launcher.

Lastly, work will be performed on this study to prepare for the next effort, which will involve actual hot-fire testing of a high-thrust vortex engine. A design of a workhorse version of this engine is a goal of the current effort and will be ready when the time comes to take this next major step on the road to flight and, finally, operational use. ■



ABOVE: *Oxygen and hydrogen burn in a VCCW chamber. The combustion chamber, constructed of Plexiglas, demonstrates the vortex cooled chamber wall concept. The Plexiglas walls remain cool and undamaged even though the temperature in the core vortex is 3000 C. (Source: Orbital Technologies Corporation (ORBITEC™))*

BELOW: *Aquarius Mission Profile. Low cost launch is achieved through relaxed reliability. (Source: Space Systems/Loral)*



Andrew E. Turner **is the project manager of the Aquarius launch vehicle development at Space Systems/Loral and was the lead mission analyst for the Globalstar constellation established by Loral and its partners; he can be reached at turner.andrew@ssd.loral.com.**

William H. Knuth **is chief engineer of Orbital Technologies Corporation (ORBITEC™) and is one of the inventors of the vortex cooled chamber wall engine.**

AAS' 44th Robert H. Goddard Memorial Symposium a Big Success

Record participation and a strong cadre of speakers prove that the Vision for Space Exploration *is becoming a reality - but that many hurdles lie ahead.*

by Jan Kalshoven and Michael Calabrese

Attendees turned out in record numbers for the 2006 Robert H. Goddard Memorial Symposium, held March 14-15 at the Greenbelt Marriott Hotel. This year's theme, "80 Years after Robert Goddard's First Rocket Flight: Engineers, Scientists and the Vision" addressed the historical anniversary and the Exploration Vision's connection to Robert H. Goddard.

AAS President Mark Craig welcomed attendees on day one and introduced Goddard Center Director Ed Weiler, who in turn introduced keynote speaker NASA Administrator Michael Griffin. The Administrator referenced Robert Goddard's "dream becoming reality" and discussed plans to implement the Vision for Space Exploration beginning with the Constellation Program. Griffin also discussed NASA's rationale for science growing at the rate of inflation and stressed the need to complete the International Space Station, retire the Space Shuttle by 2010, and hopefully squeeze in a final servicing mission to the Hubble Space Telescope. He also summarized launch vehicle capabilities needed to implement the Vision along with commercial opportunities.

Seven technical sessions filled the two day event. On the first day, NASA Exploration Systems Mission Directorate Associate Administrator Scott Horowitz keynoted a session on *Exploration and the Vision*, moderated by Constellation program manager Jeffery Hanley, Johnson Space Center.

A session on *Exploring with Humans and Robots – The Synergy of Human and Robotic Exploration*, moderated by GSFC Deputy Director Mike Ryschkewitsch, followed with panelists from NASA and academia. NASA Chief Engineer and former GSFC Deputy Director Chris Scolese moderated a panel on *Engineering the Exploration – The Challenge of Systems Engineering*. Lisa Guerra, Acting Director for NASA's Exploration Systems Mission Directorate Integration Office, led a panel on *Engineering Innovation and the Vision*.

Guest speaker John Marburger, Director of the White House Office of Science and Technology Policy, provided the keynote on day two, discussing the Vision in terms of being long-term, sustainable and affordable. He said, "The fundamental goal of this Vision is to advance U.S. scientific, security and economic interests through a robust space exploration program." He also spoke of the Vision in terms of the American Competitiveness Initiative highlighted in President Bush's recent State of the Union address.

Technical sessions on day two began with *Future Human Capital Needs of the Vision*, led by former Goddard director and current president of the Universal Space Network Joseph Rothenberg. The panel consisted of a broad representation from leaders in industry, NASA and academia addressing the educational

John H. Marburger III, Director, Office of Science and Technology Policy provides the second day Keynote address. (Source: Chris Gunn, NASA GSFC) and early career aspects impacting the workforce needs of the long term Vision.

During the luncheon on day two, Mark Craig presented the president of the Committee on Space Research (COSPAR) Roger-Maurice Bonnet with the AAS Advancement of International Cooperation Award. Craig also bestowed the AAS Eugene M. Emme Astronautical Literature Award to Margaret Weitekamp for her book *Right Stuff, Wrong Sex: America's First Women in Space Program*.

A unique afternoon session *Science is Exploration* was moderated by Laurie Leshin, Director of Goddard's Science and Exploration Directorate, and George Morrow, Deputy Director of Goddard's Flight Programs and Projects Directorate. They introduced leader pairs from their directorates who jointly addressed the major science thrust areas of Earth Science, Heliophysics, Astrophysics and Planetary Science.

ABOVE: *NASA Administrator Michael Griffin Keynotes the Symposium. (Source: Chris Gunn, NASA GSFC)* ***BELOW:*** *Gen. Lester Lyles addresses the April 15 luncheon. (Source: Chris Gunn, NASA GSFC)*

The Symposium concluded with a session on *Exploration is Science*, moderated by NASA Associate Administrator for Science Mary Cleave. The panel included two former NASA Science Associate Administrators Wes Huntress and Lennard Fisk, President of COSPAR Roger Bonnet, and NOAA Climate Program Office Director Chet Koblinsky.

A series of Innovative Outreach Videos were presented throughout the symposium, which highlighted the integrated nature of NASA's outreach efforts as an important element of scientific research, technology development and mission formulation and implementation.

Goddard's James Kalshoven led the planning committee. GSFC and industry employees made up the ten member team who worked closely with AAS executive director Jim Kirkpatrick and AAS president Mark Craig to generate this year's theme, as well as a coherent selection of sessions, moderators and presenters. Contacts for the first day were handled primarily by Mike Calabrese of SGT, Inc, Pat Rainey of The Boeing Company, and Vicki Oxenham, Harley Thronson, and Barbara Pfarr of Goddard. Kathy Nado of Computer Sciences Corporation, and Vic Teplitz and Don Savage of Goddard managed the second day's sessions. Mike Calabrese provided ideas and topics for the outreach videos which were produced by Erica Drezek of Honeywell.

Presentations from this symposium can be accessed from the AAS web site at www.astronautical.org. ■

Dr. James Kalshoven **is an electrical engineer and is currently NASA's SBIR and STTR programs' R & D Technology Manager, located at Goddard Space Flight Center. He has received both the NASA Exceptional Achievement and Distinguished Service Medals and the GSFC Inventor of the Year award.**

Michael Calabrese **is a SGT, Inc. Senior Program Analyst at the Goddard Space Flight Center supporting the Heliophysics Division. He has been a member of the Goddard Memorial Symposium Planning Team since 2000.**

American Association for the Advancement of Science Announces 2005 International Science Cooperation Award Recipients

A team of Russian and American experts surmounts political and cultural hurdles to the benefit of all.

The American Association for the Advancement of Science (AAAS), the world's largest general scientific society, named a team of Russian and American scientists to receive the 2005 International Scientific Cooperation Award. They are Dr. Kyle T. Alfriend, Dr. Paul J. Cefola, Dr. Felix R. Hoots and Dr. P. Kenneth Seidelmann from the United States, and Dr. Andrey I. Nazarenko, Dr. Vasiliy S. Yurasov and Dr. Stanislav S. Veniaminov from Russia.

Once adversaries, these dedicated scientists were honored for both their determination to transcend numerous limitations to collaboration. Their pioneering work has served to advance state-of-the-art space surveillance in both countries for the benefit of the worldwide astrodynamics community and the safety of human activity in space.

At the beginning of the Space Age, the United States and the former Soviet Union created separate systems for surveying space and classifying objects floating in space to ensure their own strategic and tactical advantage. The resulting data bases, called space object catalogs, contained regular tracks and orbital elements of the floating objects, and were not shared between the two countries. In addition to restraining advancements in astrodynamics, this information divide impeded international knowledge of all satellites orbiting the Earth and the scope and safety of human activity in space.

Beginning in 1994, the awardees embarked on an exceptional series of workshops aimed at exchanging information on the mathematical methods and systems used for space surveillance in their two countries, and ultimately on comparing space object catalogs. Given the proximity of these meetings to the collapse of the former Soviet Union, the scientists could have easily been deterred by the many logistical challenges alone. But they persevered. They held six workshops in the United States, Poland and Russia, which opened communication between U.S. and Russian experts in space surveillance, fostered cooperative research addressing common problems of space surveillance, and led to sharing of data, exchange of catalogs, and communication between people and organizations.

As a result of these collaborative efforts, it was possible to achieve near real-time determination of upper atmospheric density — the nagging problem for estimating drag on satellites — and therefore, improving the performance of low-Earth orbit satellites. The reduction in estimation errors led the U.S. National Aeronautics and Space Administration to proclaim this as the "greatest improvement in atmospheric drag modeling over the last 30 years."

Here are the background descriptions for the award winners:

- Dr. Alfriend is the Distinguished Research Chair Professor of Aerospace Engineering at Texas A&M University. He is a mechanical engineer and a recognized international expert in astrodynamics and satellite attitude dynamics and control. His research

AAAS 2005 International Science Cooperation Award recipients, Paul J. Cefola, Kyle T. Alfriend, and Vasiliy S. Yurasov.

has contributed to protecting the International Space Station from collisions with floating objects and navigating satellites.

- Dr. Cefola is a lecturer in the Massachusetts Institute of Technology Aero-Astro Department and an independent consultant, with over 30 years experience in the Aerospace industry. He is a mechanical engineer with research interests in the application of optimization techniques to the design and maintenance of satellite constellations and of parallel processing paradigms to astrodynamical problems.
- Dr. Hoots is the Group Manager of Space Programs for AT&T. He is an expert in astrodynamics and mathematical modeling, linear programming modeling and satellite motion, mechanics and geometry. He previously served in the directorate of astrodynamics at the U.S. Air Force Space Command and as an adjunct assistant professor at the University of Colorado, Colorado Springs.
- Dr. Nazarenko is the chief scientist of the Space Observation Center, Department of Information Technologies, Russian Aviation-Space Agency. His main research interest is developing the statistical theory of motion of a satellite ensemble and applying it to studies of space debris. He also helped establish the Russian Space Control System.
- Dr. Seidelmann is a dynamical astronomer and research professor in the Astronomy Department at the University of Virginia. After military service as a research and development coordinator at the U.S. Army Missile Command, he joined the U.S Naval Observatory, where he was director of the Nautical Almanac Office, the Orbital Mechanics Department, and the Directorate of Astrometry. He co-originated (with Dr. Veniaminov) the series of workshops this award honors.
- Dr. Veniaminov is an engineer and leading scientist of the Scientific Research Center "Kosmos" of the Russian Department of Defense. He is an expert in cybernatics and cooperates internationally on space surveillance and debris contamination of near-Earth space. He has helped develop a theoretical base and method for optimum search of space objects on highly elliptical orbits and in geosynchronous orbit. He co-originated (with Dr. Seidelmann) the series of workshops this award honors.
- Dr. Yurasov is a project manager for Space Informatics Analytical Systems (KIA Systems) in Moscow with more than 25 years' experience in astrodynamics, orbital mechanics and information technology, including research, development and management in public and private sectors. He has worked on optical measurements processing technology for geostationary satellite orbits, a comparison of satellite theories, and determination of satellite re-entry time with the help of numerical and semianalytical methods.

> "Their pioneering work has served to advance state-of-the-art space surveillance in both countries for the benefit of the worldwide astrodynamics community and the safety of human activity in space."

AAAS is the world's largest general scientific society, and publisher of the journal, Science (www.sciencemag.org). AAAS was founded in 1848, and serves 262 affiliated societies and academies of science, reaching 10 million individuals. Science has the largest paid circulation of any peer-reviewed general science journal in the world, with an estimated total readership of 1 million. The non-profit AAAS (www.aaas.org) is open to all and fulfills its mission to "advance science and serve society" through initiatives in science policy; international programs; science education; and more.

The recipients are active members of the AAS Spaceflight Mechanics community with numerous contributions to the Spaceflight Mechanics and the Astrodynamics Specialist Conferences and to *The Journal of the Astronautical Sciences*. ■

New Career Center Launched!

The new AAS Career Center gives employers and job seeking professionals a better way to find one another and make that perfect career fit. Visit the Career center at www.astronautical.org to post jobs or search job listings for qualified space professionals.

First Man: The Life of Neil Armstrong

Reviewed by Mark Williamson

First Man: The Life of Neil Armstrong by James R. Hansen. London: Simon & Schuster, 2005. 769 pages. ISBN: 0-7432-5963-7. £20.00/$30.00 (hardback).

On July 20, 1969, the world stood still to watch a 38-year-old American astronaut called Neil Armstrong become the first person ever to step onto the surface of another planetary body – the Moon. The words he said as he did so have gone down in history, and have been much in debate ever since (but more of that later).

This book is an important publication, because Armstrong – renowned for his shyness – has never penned an autobiography. Indeed, this is the first and only *authorized* biography of Neil Armstrong, the first man on the Moon. To fulfil his ambition to write this biography, author James Hansen drew on NASA and Armstrong family archives and conducted more than 125 original interviews (including more than fifty hours with Armstrong himself). The book covers Armstrong's career in flying, as a naval aviator, test pilot and astronaut, in 35 chapters divided into eight sections, each addressing a key portion of his life. There is also an insert of black-and-white photographs.

As a professional historian, Hansen includes a substantial (60-page) section of chapter notes, a 20-page bibliography and a massive 30–page index. According to the author, this treatment echoes the wishes of Armstrong himself, who "wanted the book to be an independent, scholarly biography".

Naturally, many contentious issues that have been argued and written about for years are included in this book. One of them is the decision regarding who should be first to actually set foot on the Moon. Hansen reviews the previous writings of Buzz Aldrin and others, relating the arguments for and against one astronaut or the other. It comes down to the fact – if indeed it is a fact – that the decision to send Neil out first was made by a group of four NASA managers who thought that, given the respective personalities involved, Armstrong was best-suited to that historic role. An interview with Armstrong reveals his apparent naivety regarding the importance of the decision in the minds of more or less anyone outside NASA. His comment that "there wasn't a lot of difference between having ten feet of aluminium leg between the bottom of the spacecraft…and the surface of the Moon and having one inch of neoprene rubber or plastic on the bottom of our boots touching the lunar surface" shows a lack of appreciation for the emotional needs of 'Joe Public' and the importance of personalities to historians.

What about those first words uttered on the lunar surface? Even now, Armstrong says he "didn't think it was particularly important" or that he "picked a particularly enlightening statement". Despite all the stories to the contrary, it seems that he came up with the idea of what to say only once the Eagle had landed. As for the famous missing 'a' in "That's one small step for man…", he is pragmatic. He can't remember whether he included the 'a', which was certainly intended, but thinks that "reasonable people will realize that I didn't intentionally make an inane statement". According to Hansen, when asked how he would like historians to quote him, he answers "only somewhat facetiously, 'They can put it in parentheses'."

The other fascinating question is why there are no posed pictures of the first man on the Moon. Was it because the astronauts were so fixated on completing their assigned tasks, or because Aldrin made a conscious decision not to photograph Armstrong? You will have to read the book to find out.

In a sense, it is sad that people fixate on these issues, rather than the broader aspects of the lunar missions, but at least if they do they are not wasting time discussing whether or not men actually went to the Moon at all. For those who weren't even born when this piece of history was being made, this book will make a fascinating read; for those who were, and remember watching those blurry black-and-white TV pictures from the edge of their seat, the book is an absolute must. ■

Mark Williamson **is an independent space technology consultant and author.**

Student Teams Participate in AAS National Conference and 52nd Annual Meeting

AAS provides future aerospace leaders with a unique opportunity to feed their enthusiasm and stretch their skills alongside working professionals.

by Alicia Baker

On November 15th and 16th of this year, the AAS hosted its National Conference at South Shore Harbor in League City, Texas. The conference theme was "Building Bridges to Exploration: The Role of the International Space Station". Various sessions were held to discuss the role of the ISS in the future of space exploration- the journey back to the moon, Mars, and beyond.

The conference opened with a greeting from the ISS Expedition 12 Crew Commander Bill McArthur and Flight Engineer Valery Tokarev. Former Johnson Space Center (JSC) director, Jefferson Howell, Jr., then introduced the keynote speaker, NASA Administrator Michael Griffin. Dr. Griffin discussed how our next step in supporting President Bush's Vision for Space Exploration is to complete the assembly of the ISS and then use the ISS to further exploration beyond lower Earth orbit. Before the sessions began, a quick presentation was made about the NASA Means Business student competition. The objective of the competition is for students to come up with a promotional product, such as a video, that communicates to the general public how import NASA space exploration programs are to life here on Earth. Sessions about the role of the space station then included aerospace professionals from all over the world. Representatives from the US space program, Russia, the Canadian Space Agency (CSA), the European Space Agency (ESA), and the Japan Aerospace Exploration Agency (JAXA) discussed the roles they play in the ISS program.

Students listen to their teammates as they present ideas on how to utilize the ISS as a testbed for Exploration technology during the American Astronautical Society Conference held Nov. 15-16, 2005 in League City, Texas. (Source: NASA)

I had a unique opportunity as a student to participate in a student workshop as part of the session: "ISS as an Exploration Mission Testbed." Student Session Chairman, JSC's Paul Brower, helped organize students into teams that worked together before and during the conference to develop ideas on how the ISS can be utilized for testing technologies that will help us continue with our journey into space. Teams consisted of students from all over the country from various disciplines from physics to engineering majors. Teams included Habitability, Robotics, Maintenance, and Medicine/Life Support Technology. Each team was given the task to develop a concept and prepare a 10 minute presentation. Prior to the conference students used an online chat room, discussion board, email correspondence, and teleconferences to prepare their presentation.

Each student team was assisted by an aerospace professional with experience in one of the four areas. Team mentors answered questions about their area of expertise. They assisted students in dividing up research and presentation responsibilities. A student lead was chosen to facilitate turning in pre-conference work to the student session committee. Students had to demonstrate their progress in various stages. Stage one included presenting a list of brainstormed ideas. Stage two included selecting a final idea and providing an outline to topics to be discussed during presentation. The final stage consisted of a draft PowerPoint presentation. On the first day of the conference, students were able to attend the aerospace professional sessions. We then were treated to a pizza party at the Gilruth where students and mentors met for the first time! On the second day of the conference, students fine-tuned and practiced their presentations. We took a break during the day to attend the conference luncheon where the speaker gave an update on the Chinese Human Space Flight Program. When it was time for the student session of the conference, students presented their ideas to a NASA panel that included astronauts Michael Foale and Scott Altman and AAS Houston Conference Planning Chair Nicholas Skytland.

My team was the habitability team. It was an eye opening experience learning about the importance of habitability in the space program. Habitability involves trying to create a safe and productive environment for the astronauts while living in space for extended periods of time. Our team mentor was Cynthia Rando from the Muniz Engineering, Inc. (MEI) ISS Flight Crew Integration Habitability and Human Factors Office. Our concept was "Virtual Earth". We were hoping to find a way to help alleviate homesickness for astronauts that are away on long duration space missions. It could be tested on the ISS and then used on a lunar base or a mission to Mars.

As an inspiration for our concept, we looked to astronaut John Phillips of Expedition 11 for inspiration: "It's kind of a sterile environment; I want to experience weather, the smell of trees, even the sound of cars going by, something that's more like the real world that I live in back home." Each astronaut would have a "Virtual Earth" module in their quarters that would consist of a LCD screen, speakers, web cam, optional headphones, and light boxes hooked up to a central computer.

ABOVE: *NASA astronaut C. Michael (Mike) Foale discusses his experience on the international space station with Richard Rhodes, a student session participant. (Source: NASA)* ***BELOW:*** *American Astronautical Society conference student participants and mentors gather for a photo with NASA astronauts C. Michael (Mike) Foale (far left) and Scott Altman (wearing blue flight suit on rear row). Also included is Mark Craig (far right), the society's president. (Source: NASA)*

"Virtual Earth" would have three different modes: "Earth Environment Simulator," "Window View," and "Family Interaction". The "Earth Environment Simulator" would provide day and night time pictures and video from earth, including scenes from astronaut's home towns. Light boxes would be attached on both sides of the LCD screens to provide light therapy. They would provide specific wavelengths of light similar to those provided by the sun. Lack of exposure to sun light on long duration space missions could affect an astronaut's circadian rhythm-lead to an increase in the hormone melatonin and a decrease in energy levels. "Window View" would provide views of outside a space vehicle from cameras mounted on the vehicle. When astronauts where out of range of the earth, they could watch pre-recorded video of the Earth from orbit. The LCD screen would act as a window without the radiation effects of having a window in an astronaut's crew quarters.

"Family Interaction" mode would feature a live feed for family conferences and an option to view family videos when astronauts where out of live feed range.

It would provide private time with family and psychological support for long duration missions. Using current technology and a small budget, "Virtual Earth" could be tested on the ISS. We hoped it would make living on a moon base easier and the long journey to Mars feasible from a habitability standpoint.

The Robotics team proposed concepts for robots that would help astronauts with both Intravehicular Activity (IVA) and Extravehicular Activity (EVA). Maintenance group felt that a database listing all hardware and components on the ISS should be maintained in order to facilitate repairs and upgrades on the station. The Life Support group came up with the concept of using planters designed to grow plants in a hexagonal pattern in order to maximize use of volume on the ISS.

> "John Philips of Expedition 11 [said], "It's kind of a sterile environment; I want to experience weather, the smell of trees, even the sound of cars going by, something that's more like the real world I live in back home.""

The panel critiqued each group's presentation-providing both positive feedback and constructive criticism. The winning student team, Life Support, received travel funds to assist with the costs of travel to Greenbelt, Maryland, where they will present their concept at the Robert H. Goddard Memorial Symposium in March of 2006. All students were treated to a photograph with the astronauts and signed certificates of participation from Foale and Altman! This conference was an exciting time! I learned a lot about the ISS and its future in helping us prepare for a moon base and the long journey to Mars and beyond. I thoroughly enjoyed attending the professional presentations and hearing from aerospace professionals from all over the world! Working with students from all over the country on a team project was a very unique experience! I enjoyed seeing all the student group final presentations. I was also nice to run into other students in AIAA from other universities! I look forward to the return of the conference to our area in 2008! For more details about the conference, including a transcript of Dr. Griffin's speech, go to www.aashouston. org.

For details about the NASA Means Business student competition, go to www.tsgc.utexas.edu/nmb/this.html. ■

***Alicia Baker* is a student member of the University of Houston AIAA Chapter and serves on the Houston AIAA GN&C Committee. She is also Project Engineer Intern for the NASA-funded Space Alliance Technology Outreach Program (SATOP) run by the Bay Area Houston Economic Partnership (BAHEP).**

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Articles can cover virtually any topic involving space science, technology, exploration, law, or policy. We welcome articles that touch on issues relevant to the civil, commercial, and military and intelligence space sectors alike.

Articles should be written for a well-educated audience that has great interest in space topics but may not necessarily be familiar with your specific topic.

We are a magazine, not a technical journal. Articles should be written in active voice and should explain technical concepts clearly. Tone should lean more toward conversational rather than stiff and formal. We do not include references with articles.

Deadlines occur six to seven weeks before the first month of the issue in question (e.g., ~Jan. 15 for the March/April issue). Exceptions are possible if discussed with the editor.

Articles should be submitted in Microsoft Word format, Times New Roman font. No need to worry about other formatting specifics – we'll take care of the rest in the editing process.

Authors should provide with their articles: a title, a "subtitle" of one or two sentences summarizing the idea of the article, sub-heads within the article that provide separations between the major sections of the article, and an author biography of one to two sentences to appear at the end of the article. You should also send a mailing address so we can send you complimentary copies of the issue in which your article appears.

Authors are encouraged but not required to submit photos or other visual supports for their articles. Suggestions for photos or visuals are also welcome. Photos need to be of high resolution (at least 300 dpi) and can be in JPG, TIF, or GIF formats. We must receive permission from photo owners to use photos, so please provide proof of permission or contact info for the photo owner if you haven't already secured permission.

A few style pointers:

- Units of measurement should be conveyed in metric, not English, terms.
- Acronyms should be used sparingly, and only when a term is used several times.
- Names of specific spacecraft (e.g., *Columbia*) should be italicized. General spacecraft names (e.g. space shuttle, Delta) should not.
- Numbers one through one hundred should be spelled out.

Contact: Jonathan Krezel, editor (jonathan.krezel@gmail.com).

2006 Space Events

May 20 – Team America Rocketry Challenge
at The Plains, Virginia.
www.aia-aerospace.org/aianews/features/team_america

June 4-7, 2006 – SPACE BLITZ 2006
in Washington, D.C. Do you want to make a difference? The National Space Society (NSS), with the support of AAS and other organizations, is planning the biggest Blitz yet! Volunteers will visit every Congressional office in Washington, D.C. to support the Vision for Space Exploration.
www.nss.org/legislative/index.html

July 17-21 – GPS/GNSS Symposium
sponsored by the International Global Navigation Satellite Systems (IGNSS) Society at the Holiday Inn Surfers Paradise, Queensland, Australia.
www.ignss.org

September 19-21 – Space 2006 Conference
"The Value Proposition for Space – Security, Discovery, Prosperity"
at the San Jose Convention Center, San Jose, California.
www.aiaa.org

November 9-11 – Space Vision 2006
Students for the Exploration and Development of Space (SEDS) 3rd National Conference at the University of Central Florida in Orlando.
www.seds.org

Charitable Giving and the AAS

A popular way to donate to an organization is to make a gift by means of a will, i.e., make a bequest. You may wish to consider either a general bequest to AAS, or a bequest targeted to an existing or new AAS scholarship or award fund. Such bequests are deductible against estate and inheritance taxes. Of course, there are also tax advantages to making charitable donations to AAS while you're living. Such gifts could give tribute to the memory of someone who has passed away or be in honor of a person still living. Special occasions offer other opportunities for gifts to be directed to the Society. As a final note, although AAS can provide suggestions for charitable giving, such actions should always be reviewed by your financial or legal advisor.

UPCOMING EVENTS

AAS Events Schedule

June 2–4, 2006
***Student CanSat Competition**
Great Meadow
The Plains, Virginia
www.cansatcompetition.com

June 4–7, 2006
***SPACE BLITZ 2006**
Washington, D.C.
www.nss.org/legislative/index.html

August 21–24, 2006
***AIAA/AAS Astrodynamics Specialist Conference and Exhibit**
Keystone Resort & Conference Center
Keystone, Colorado
www.aiaa.org

November 14–15, 2006
AAS National Conference and 53rd Annual Meeting
Pasadena Hilton
Pasadena, California
www.astronautical.org

January 28–February 1, 2007
***AAS/AIAA Space Flight Mechanics Winter Meeting**
Hilton Sedona Resort & Spa
Sedona, Arizona
www.space-flight.org

February 3–7, 2007
30th AAS Guidance and Control Conference
Beaver Run Resort
Breckenridge, Colorado
www.aas-rocky-mountain-section.org

March 2007
45th Robert H. Goddard Memorial Symposium
Washington D.C. Area
www.astronautical.org

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