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SPACE TIMES

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Preparing the Next Generation of Space Professionals

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American Astronautical Society

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Editor's Message

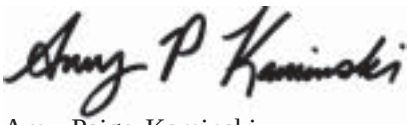
Is the space industry heading towards a workforce crisis in the next several years? As space professionals, we can hardly attend a conference, workshop, or other industry event that does not in some way or another lament or warn of the difficult road ahead for governments and private organizations to attract young people to the field and to work for these potential employers. While the bottom-line message of virtually all of these sessions is that the industry needs to scramble to find ways to get youth interested in space careers, it's essential that the space community focuses on the right set of issues when planning for the future of the industry.

Clearly, there is a continued demand for aerospace workers. Regardless of the fact that the Apollo days are bygone and that the commercial demand for satellite launches has not panned out as projected in the late 1990s, we are still a nation devoted to exploring and using space. Innovation and technological prowess are still American ideals, satellite services pervade many parts of daily life, and President Bush has committed the nation to a future in human and robotic space exploration. All the while, the demographics of the NASA workforce and of large aerospace companies suggest that a huge wave of retirements—and hence the loss of a vast amount of knowledge and experience—may be imminent. New, enthusiastic scientists and engineers must be found, many in the industry proclaim, to keep America strong in space.

Usually that is where the story ends. The piece that tends to go unnoticed is the fact that the youth of today have not altogether lost interest in space as a profession. As a young professional in the field, I have encountered dozens upon dozens of others like me who have aspired for much of their lives to find meaningful employment in a space-related field. NASA along with numerous companies and research organizations currently do a tremendous service to the space community by offering students incredible opportunities to get involved early on in the field—and the number of applicants for these internships tends to far exceed the number of slots available. As Karen Rugg and Srimal Choi show in their articles, teachers and organizations—from big-name NASA to small nonprofits like Project INSPIRE in Utica, Michigan—are working tirelessly to mint young people that will be prepared and excited to take over their predecessors' reins.

As I see it, the real challenge for the space industry in the upcoming years is not to fixate on boosting supply but rather to ensure that the supply of young space professionals and the demand for new workers match up effectively. The key? Those eager to enter the aerospace workforce and those searching for new employees need to be sure to go the distance to understand their mutual expectations. Up-and-coming scientists and engineers, for their part, must be familiar with the landscape of today's aerospace industry and be ready to prepare and market themselves to meet the employment needs of space-related companies and organizations (see the articles in this issue by Reece Lumsden and Jose Guzman addressing this point). At the same time, employers can assure their successful futures by keeping the processes for applying for jobs simple, looking to previous interns as potential candidates for vacant positions, and—most importantly, as writer Sarah Ramsey alludes—tasking entry-level workers with satisfying projects and offering challenging goals.

Preparing the next generation of space professionals is a critical task, and current methods can always be improved. But with much of the groundwork done and with sharp, energized young people waiting in the wings, the process should not be an arduous one.



Amy Paige Kaminski

ON THE COVER

Brian Nord, currently a physics graduate student at the University of Michigan, positions a theodolite to measure diffraction on a reflective surface as part of research to improve the alignment of space telescopes. Nord performed the research at NASA's Goddard Space Flight Center during the 2004 NASA Academy, a summer program designed to introduce undergraduate and graduate students to NASA research and prepare them for careers in aerospace-related fields. (Source: NASA Academy)

AAS National Conference and 51st Annual Meeting

"Transformation and Vision for Space: NASA's Partnership with Industry and Government"

November 16-17, 2004
Pasadena Hilton, Pasadena, California

TUESDAY, NOVEMBER 16

7:30 am **Registration / Continental Breakfast**

8:45 am **Welcome**

Jonathan T. Malay, AAS President
Lockheed Martin Corporation
Charles Elachi, Director, Jet Propulsion Laboratory, and Director of Advanced Planning, NASA Headquarters

9:00 am **Carl Sagan Memorial Award Lecture and Presentation**

Steven Squyres, Professor of Astronomy, Cornell University; Principal Scientist, Mars Exploration Rover Team

10:00 am **Break**

10:30 am **Session 1: Status and Future of the Robotic Scientific Exploration Program**

Mars
Firouz Naderi, Director, Mars Program, Jet Propulsion Laboratory

Cassini
Robert Mitchell, Program Manager, Cassini, and/or Dennis Matson, Project Scientist, Cassini (invited)

12:00 pm **Luncheon**

Al V. Diaz, Associate Administrator, Science Mission Directorate, NASA Headquarters

1:30 pm **Session 2: Focus on Education**

Adena Loston, Chief Education Officer, NASA Headquarters

2:30 pm **Break**

2:45 pm **Session 3: Focus on Public Engagement**

Neal M. Burns, Director, Center for Brand Research, College of Communication, University of Texas

Roundtable

Moderator: Blaine A. Baggett, Office of Communications and Education, Jet Propulsion Laboratory

Space and the 2004 Presidential Campaign

As of press time, Senator John Kerry's presidential campaign headquarters had not issued a policy statement on space, and AAS believes it is unlikely that he will make it a campaign issue. AAS does not expect that President Bush will make space an issue of his campaign, either, since his policy is reflected in the space exploration vision he announced earlier this year.

For the latest details on the candidates' public statements and policy positions, check out the official Kerry and Bush web sites as well as the Republican and Democratic web sites:

www.johnkerry.com
www.democrats.org
www.georgewbush.com
www.gop.com

Panelists: Gregory W. Hayes, Director, External Relations, NASA Johnson Space Center
Neal M. Burns, Director, Center for Brand Research, College of Communication, University of Texas
(Others TBD)

6:30 pm **Reception & Awards Banquet with Speaker**

WEDNESDAY, NOVEMBER 17

7:30 am **Registration / Continental Breakfast**

8:30 am **Session 4: Exploration Program**

Shuttle Return to Flight Status
Wayne Haye, NASA Johnson Space Center
International Space Station Status and Future Plans
William H. Gerstenmaier, Manager, Space Station Program Office, NASA Johnson Space Center

10:00 am **Break**

10:30 am **Session 4 Continues**

Crew Exploration Vehicle (CEV) Status
Speaker TBD
Prometheus/Jupiter Icy Moons Orbiter (JIMO) Status
John R. Casani, Manager, JIMO Project, Jet Propulsion Laboratory

12:00 pm **Luncheon**
Election Results and Implications for Space Policy
Rep. Jerry Lewis (R) (invited) and Rep. Bradley Sherman (D) (invited)

1:30 pm **Session 5: Plans and Acquisition Models**

NASA System Engineering/Acquisition Model
Speaker TBD
Industry Experience with DoD/Navy Acquisition Model
Chuck Allen, Vice President for Space Exploration, The Boeing Company

2:30 pm **Break**

3:00 pm **Session 5 Continues: Roundtable on Industry/Government Partnerships**

Moderator: Robert Walker, Chairman, Wexler & Walker Public Policy Associates (invited)

Panelists: Eugene Tattini, Deputy Director, Jet Propulsion Laboratory
Christopher J. Scolese, Deputy Director, NASA Goddard Space Flight Center (invited)
Chuck Allen, Vice President for Space Exploration, The Boeing Company
Speaker TBD

5:00 pm **Closing Reception**

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Space Science Education: A Race to Pass the Passion

The summer's Tour de France bicycle race provides context to the efforts of executives, teachers, and other leaders who hope space science can attract youth to careers in science, technology, engineering, and mathematics.

by Karen L. Rugg

July 19—it's the final week of the Tour de France. As I get swept along with the riders, reveling in unique Tour terminology such as *peleton*, *bonk*, *kreeged*, and *hooptey*, I realize that space science—the study of the solar system and the universe beyond—is the Lance Armstrong of the education world. In the race to draw kids to the wonders and benefits of science, technology, engineering, and mathematics (STEM), leading educators, elected officials, and potential employers hope the wonders of space can get them into the start house.

And this race is on. The No Child Left Behind Act of 2001 contains language driving the application and measurement of math and science curricula. The U.S. House of Representatives recently formed a STEM caucus to "promote and improve all areas of science and math education including K-12, higher education, and workforce issues in Congress" and "to increase the visibility and importance of STEM education and work to educate members of Congress and their staff on the issues surrounding STEM education." So far, thirty-two members have joined. The NASA Flexibility Act of 2004, passed by the House and Senate, addresses the "brain drain" at the space agency, giving it more flexibility to recruit and retain a highly skilled workforce. The Aldridge Commission's final report on the implementation of the new U.S. space exploration policy states that "NASA is in a unique position to engage young people in their studies through the excitement of space exploration." To professionals striving to win the race for young minds, space science is attractive because it integrates the disciplines that form STEM.

Is space science destined to be the poster child for STEM education? Is it a fair expectation? And do we know if space science works as the subject upon which all other subjects can draft, making the ride easier for everyone?

Students receive instruction in a space station simulator at the Challenger Center in Alexandria, Virginia. (Source: Challenger Center)

Mapping the Route

At the start of each Tour day, Outdoor Life Network commentators Al Trautwig and Bob Roll display a computer-generated image of the day's route. While describing each day's stage of the race, they place it in the context of the entire three weeks of competition. So I went in search of a comparable bigger picture for space science education.

When you perform a Google search for "space science," the first link to appear is that of the Challenger Center for Space Science Education. Dr. Bill Gutsch is the new chief executive officer and president of the Challenger Center. For more than thirty years as an educator, writer, scientist, television producer, and administrator, he has engaged the public on astronomy and science. For someone who came to the Challenger Center just four months ago

from his position as chairman of the American Museum of Natural History and Hayden Planetarium in New York City, Gutsch has a strong idea of where things stand.

"One of the frustrations to me is that, in the actual core curriculum, space science is a narrow little wedge of part of another narrow little wedge called Earth science that manifests itself here and there in the K-9 curriculum and that *may* pop up a month or two in eighth or ninth grade science," Gutsch says. "It's unfortunate because the universe is a big place and our Earth is a tiny speck—it seems out of proportion."

During the next few minutes of conversation, he reveals what will be common themes from teachers, researchers, and program developers involved in space science education. The first is that being a great teacher comes down to knowing your subject matter and caring about your subject matter. That's how the passion is passed. The second is that young people must be made aware of the fact that thousands upon thousands of people—engineers, scientists, writers, public relations people—make a space mission possible. It's not all about being an astronaut because not everyone can be. "Everybody's essential. If space gets you excited, you can dream about participating in an active way," Gutsch says.

A third theme is that teachers are key. When asked what he would say to the Bush administration about how it can support space science and encourage STEM, Gutsch replied, "We need to do everything we can to ensure that the people in the formal and informal education sectors are the best trained and qualified and enthusiastic people we can possibly create. The other way I'd try to sway a president's heart is to give money to programs that are going to help create a critical bridge between what the child experiences in his classroom and what the child experiences later at home in the evening and on weekends." He asserts that parents must feel they're in a position to take an interest in what kids learn after school.

In an engineering teamwork exercise at Project INSPIRE in Utica, Michigan, a student-parent team assembles a geodesic dome with only a box of parts, a blueprint, and twenty minutes. Project INSPIRE uses aerospace simulators to motivate students and parents in the greater Detroit area to higher achievement in science and math. (Source: Project INSPIRE/Raye Klopfenstein)

The *Domestiques* of Space Science Education

In Tour de France parlance, teachers are the *domestiques* of space science. They are the people who, after seeing new learning standards strip core curricula to the basics a few years ago, have worked to inject the "cool factor" of space back into the classroom wherever they can. These learning standards, or "Standards of Learning" (SOL) in some states, are the benchmarks created by boards of education to define what each student is expected to recall, replicate, manipulate, understand, or demonstrate in subjects including science, English, and mathematics.

Teachers, in true domestique fashion, are sacrificing position and glory for the good of the whole. They are doing the hard work to keep space science in the race.

Lisa Bacon, membership activities liaison for education at the American Institute for Aeronautics and Astronautics, sees these characteristics among her fourteen hundred educator associates. "The SOL have driven a lot of things into the classroom and a lot of things out—rockets, airplanes, the fun stuff of science. Our educator associates are committed to SOL, but they're trying to sneak the fun stuff back in. Teachers have been struggling to keep kids engaged. As NASA's Earth science missions involve weather forecasting and other data-gathering with easily-drawn applications to everyday life, teachers are inspired to keep kids interested."

Bacon echoes Gutsch's theme that teachers are key. "You know you can't reach every student individually, but with teachers you know you're impacting twenty-five kids per classroom in elementary school, maybe 150 or so per year." And Bacon emphasizes the importance of training teachers: "Making teachers more comfortable teaching the material gets them excited and interested, and that will make a big difference at some point."

Karen Hall is a seventeen-year teacher of integrated physics and chemistry at LaPorte High School in LaPorte, Texas. She teaches the "reluctant science students"—kids who have no ex-

Pat Palazzolo (right) stands with House Science Committee Chairman Sherwood Boehlert after receiving Women in Aerospace's 2002 Aerospace Education Award. (Source: Women in Aerospace)

pectations to go to college. But even in that setting, Hall finds that space reels them in. "I start my year by showing the movie *Apollo 13*," she says. "We spend time talking about the applications of space and why it's important for them to learn about the space program and how it impacts their lives on a daily basis. I then use that for the rest of the year to focus them on a concept, such as weight versus mass."

Her experience has taught her another key theme: "What it takes for any of us to be interested in anything is to see it and use it." Space science helps to make space relevant. She recounts the story of one student who started as a janitor at the Sonny Carter Training Facility at Johnson Space Center and worked his way up to being a diver at the facility's neutral buoyancy training lab. He told Hall later: "I remember we always used to talk about space in class. I thought, 'I want to work there,' and you always told us we could."

Hall leaves us with this reality check: "I've realized that my students won't always remember the scientific principles. But the most important thing is that these kids we educate now are the ones who are going to decide whether or not we have a space program, whether or not we're going to continue to be explorers, whether or not we're going to sit back and wait to see what other people discover and then use their work."

Pat Palazzolo is a multi-award-winning teacher in the Upper St. Clair School District outside Pittsburgh, Pennsylvania. She was one of the state's two finalists in the Teacher in Space program of the 1980s, is a NASA Space Ambassador, uses space-themed lesson plans in her classes regardless of subject, and mentors students in the pursuit of their career goals and dreams.

"Unfortunately, I'm seeing a sating of space in the high school curriculum," says Palazzolo. "Schools are pushing AP [advanced placement] courses that are important but that don't talk about or relate to space science. Leaders are missing how many different disciplines are touched by space science. NASA realizes it, as do our new Educator Astronauts. But our leaders aren't reaching high enough."

Like teacher Karen Hall, Palazzolo has nurtured students into careers in space science. A student who participated in the Challenger Center's Marsville program, a twelve-week project during which students plan a mission to Mars and a multi-national settlement on the Red Planet, was selected by NASA for a co-op at Johnson Space Center. Apparently Johnson was fascinated by the air and water supply systems he built for Marsville. "Who would have thought that it would be what I did in middle school that got me connected to NASA?" he recalls.

Palazzolo also has a specific recommendation on how the White House and the Department of Education can help. "We should offer an advanced Earth and space science course at the high school level. As in government and politics, if even for just one semester, there should be an AP elective specifically about space science that covers the fields of engineering and sciences. [A course like] that would connect the disciplines and keep the career opportunities alive and in front of the students. We need to help students integrate the sciences and connect them to real life." She adds that some of NASA's best programs are those available to college students, and so it is important to reach out to high school guidance counselors who can give college-bound students a "heads up" on programs to consider.

A Matter of Seconds

Measuring the results of a race like the Tour de France has come down to a science. Riders flash across the finish line as "photo finishes" and microchips on each bike determine the winner down to fractions of a second.

If only determining the impact of space science education could be so easy. The voices of experience confirm that space science successfully engages youth, but the question from nonprofits and government agencies and companies that invest in space science education products is, does it work? There are some answers, primarily anecdotal and affective, but the important trend is that the answers are hardening.

The Challenger Center operates fifty-two simulation centers in the United States, Canada, and England. It also fields a program called "Journey through the Universe" that tours schools to visit youth, train teachers, and bring science programming to families. To date, the Challenger Center has collected anecdotal evidence of program impact, but Dr. Gutsch's goal is "to increase the amount of testing we do across all of our programs and services. We have good anecdotal and affective numbers, but we want more cognitive numbers."

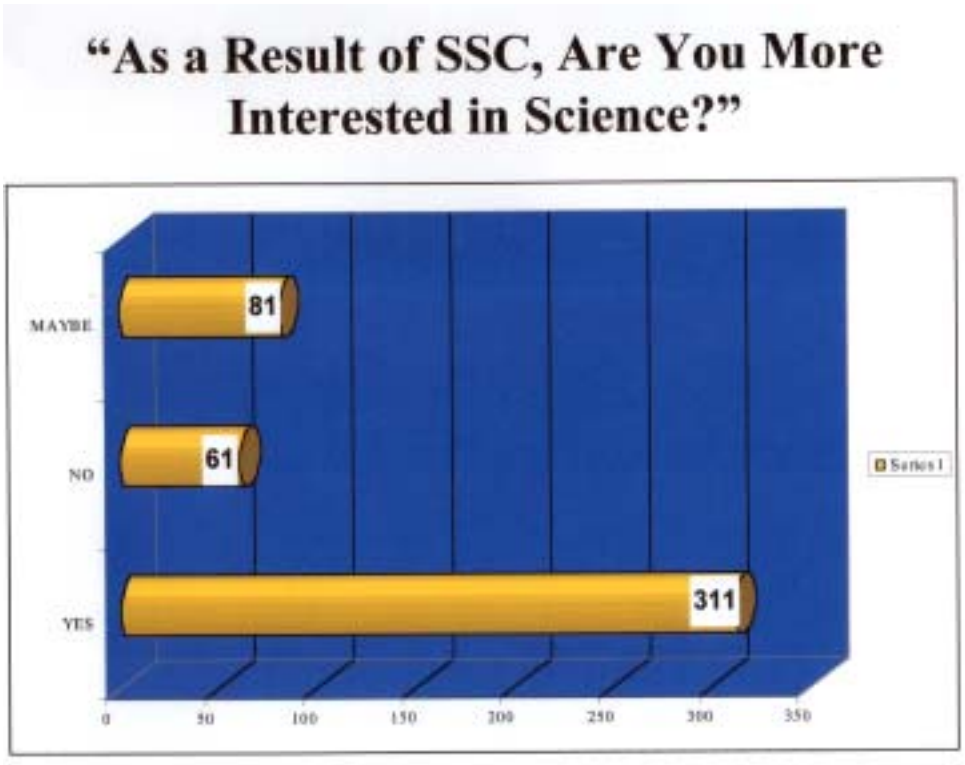
The Boeing Company's Summer Science Camp (SCC) has been lauded for its efforts to track participants for a few years to discover whether their interest in science carries through to career choices. The approach is currently "soft," but Project Manager Marie Mungaray says the feedback is still valuable. "Many of the kids who return year after year later return to volunteer and mentor the younger kids," she explains. "Boeing has hired several SCC participants as college interns, and several were recently hired by Boeing after graduating from college. Five or six former SCC participants are now workshop leads teaching the same projects they did as kids."

Dr. Carole Cameron Inge, executive director of the National Institute for Technology Policy and Research (NITPR) at Longwood University in South Boston, Virginia, is the lead for a new research agreement between NITPR and NASA's Center for Distance Learning (CDL). During the next year, NITPR will develop an educational technology method to test student achievement related to CDL content such as NASA's Kids Science News Network, NASA SCIence Files, NASA CONNECT, NASA LIVE, and NASA's Destination Tomorrow. "We're primarily looking at student achievement related to the content and then to achievement related to the method of delivery of the content, whether that be streaming video or two-way interactive video. But first and foremost is student achievement," Inge says. Data collection for CDL products before this study had been primarily summative, meaning data were collected to determine usage, distribution, or penetration of the product into the target audience. Summative research tends not to explore the impact of a program. Inge believes the new NITPR method will offer one of the first formative evaluations of CDL content, examining the effects of CDL products on student achievement and youth interest in science overall.

NITPR has been busy in recent years because, as Inge notes, a couple of things have happened. "The No Child Left Behind Act of 2001 has over one hundred references to scientifically-based research and calls for 'quantitative, rigorous evaluation that measures [program] impact on student achievement.' Companies with education products are putting serious dollars into evaluation. We've been very busy."

Inge also echoes a common theme: to make space science relevant through application. "One of the key values of NASA content is that it pre-

> "One of the key values of NASA content is that it presents science in a very exciting, applied manner... Many kids who may have never thought of math or science as useful or relevant will find information and role models that apply to them." – Carole Inge



The results of a 2003 survey of Boeing Summer Science Camp attendees demonstrate the influence the program is having on student interest in science.

sents science in a very exciting, applied manner. The science applications NASA presents range from testing new types of tires for the space shuttle to helping tag and track turtles in the Chesapeake Bay. Behind these applications are people with very diverse interests and backgrounds. Many kids who may have never thought of math or science as useful or relevant will find information and role models that apply to them."

The NASA CDL study launches this fall. What is promising is that, according to Inge, NITPR will be doing formative types of research for NASA for the next several years. "It's wonderful, actually," she says. She then offers this prediction: "The science of evaluation is an ever-growing and changing field. In the 1960s we saw a qualitative movement, and today we see a re-focus on quantitative measures. Education evaluation designs—because content and method of delivery are dynamic—will have to become more sophisticated. As NASA takes its content into 3D or creates virtual environments online, or as kids become avatars and take on the personas of objects online, we'll have to see more sophisticated approaches. We're definitely in a long-term scenario with NASA CDL, not only for the evaluations but also to contribute to NASA's development of emerging technologies."

There is no doubt that space science is still "cool" and that it contains the stamina and strength to capture the interest of any youth, regardless of socioeconomic status, education level, or career goals.

Rules of the Road

There is no doubt that space science is still "cool" and that it contains the stamina and strength to capture the interest of any youth, regardless of socioeconomic status, education level, or career goals. And it is encouraging that a number of efforts are underway to conduct more rigorous evaluations of space science education programs.

But to protect the STEM education movement from being dropped off the back of the peloton, teachers, evaluators, and space science education product providers remind us of a number of key points:

1. Educators and professionals need to help youth "see it" and "use it" if they expect them to understand the relevance of space science.
2. Educators, guidance counselors, career advisors, and parents should remember that space science is not done only by astronauts. It is important to communicate to youth the depth and breadth of available career opportunities.
3. Leaders need to recognize, when setting expectations and program benchmarks, that the current level of curriculum focus on space science in schools is dangerously small.
4. Programs are needed in middle schools to bridge the gap between elementary and high schools.
5. Evaluation models need to adapt as content, and the technologies that deliver that content, change rapidly.
6. Teachers recognize the unique ability of space science to provide an integrated view of the basic sciences (physics, chemistry, biology). This ability should be exploited.
7. Teachers are key. The best trained and motivated teachers will inspire others, and their students, to "pass the passion." ■

Karen L. Rugg **is president of Karlynne Communications, which specializes in developing creative concepts for public education and engagement campaigns. She is currently president of Women in Aerospace and is credited as a co-writer with John Spencer of *Space Tourism: Do You Want to Go?* released by Apogee Books in September 2004.**

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Space Times seeks a volunteer to assist in selecting photos and graphics to accompany articles appearing in the magazine. No graphics or editorial experience is necessary, only an eagerness to unleash one's visual creativity in support of up to six issues each year. Contact Amy Kaminski, Space Times editor (amypkaminski@yahoo.com), for more details.

The Aerospace Industry: A Professional's Survival Guide

New customer demands and other business factors are dramatically changing the workforce needs—and hence the employment standards—of aerospace organizations.

by Reece Lumsden

If you've looked at various aerospace industry magazines over the last few years, there's been a recurring theme mentioned with a growing sense of urgency. The issue at hand, common to a multitude of technology industries worldwide, is that the aerospace industry is not well, indicated by the number of jobs lost and the growing problems in sourcing new talent. This article will provide an insight into the issues ranging from the state of the launch industry and the current employment market to the kinds of skill sets required of those wanting to enter the industry at this time of unprecedented change.

Before progressing any further however, I need to define my terms. Exactly what do I mean when I talk about the aerospace industry, or the space industry as a subset of the former? It's more than just semantics because if, when looking at the space industry one just considers the space segment, he or she is obviously taking a very small sample of companies. But taking too broad a view and considering all those companies deriving some kind of revenue from space probably results in more organizations being included than excluded. Microsoft is not part of the space industry, yet software and information technology have a huge role to play. Due to this ambiguity in definition, I'll focus on the most obvious elements of the space industry: launchers and satellites.

Launch Vehicles and Satellites

Most people associate launch vehicles and satellites with the space industry more than any other commodities. The problem, however, is that these portions of the industry have relatively flat revenue projections and hence offer limited prospects for any substantial growth. A recent article in the *Australian Financial Review*, for example, reported that low commercial demand combined with a suspension from making bids on new federal launch contracts could cost Boeing's rocket and satellite manufacturing division up to $100 million.

Why is that? Is Boeing doing something wrong or wasting resources? Quite the opposite, in fact. As Boeing's profit projections are up for 2004, one can't say it's a systemic company issue. No, the heart of the matter is that Boeing, like most other launch service providers, doesn't offer any prospects for growth because the launch industry is heavily saturated and is showing signs of consolidation.

If we turn our attention to the development of launch vehicle technology itself, there is also little growth. This is because the launch systems around today are pretty much the same as they were twenty or thirty years ago. Of course, there have been some efficiencies gained here or there, but fundamentally, chemical propulsion using solid and liquid propellants has not really changed.

From Abraham Maslow's *Hierarchy of Needs*, we know that "satisfied needs no longer motivate." In terms of launch vehicle use, this means that clients have no need to get into space via new means because current systems already provide for them. They will only consider alternate means if they come at a significantly lower price than the $10,000

As long as customers are content with the services provided by expendable launchers such as the Atlas 2AS shown here, launch companies are unlikely to fund new rocket technologies, without which no new jobs will emerge. (Source: International Launch Services)

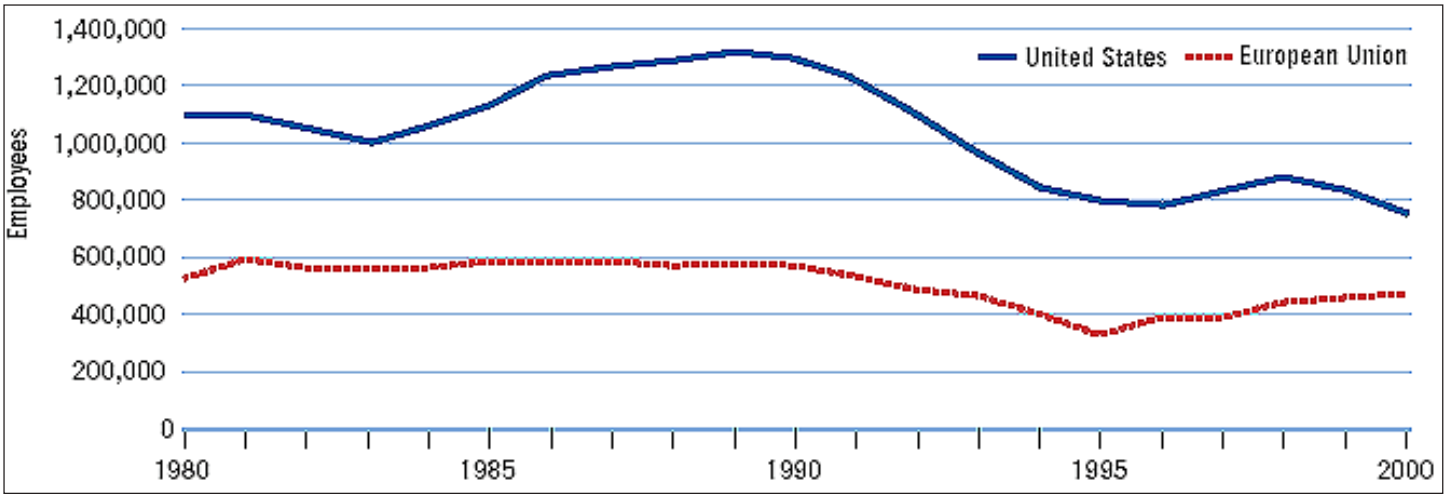


Figure 1: Aerospace employment in the United States and the European Union, 1980–2000. (Source: Final Report of the Commission on the Future of the United States Aerospace Industry)

per kilogram currently offered, which is something that the Ansari X Prize competition is designed to address.

The development of launch vehicles in most parts of the world has come through government, usually military, programs. Why? Because they saw dual-use applications early on and tended to be strategic in their approach to development—and they have very large capital budgets at their disposal. After the fundamental launch vehicle technologies were developed, commercial entities saw they could be turned into applications that people would buy. They had little need to pay off huge amounts of research and development investment as most of it had been done by the military; as a result, commercial providers didn't have to wait long before making a profit.

This hints at why launch service providers have no need or reason to shift from using expendable launch technology: they are still able to extract profits from the vehicles they currently have. If they were to move on to develop new launch vehicle technology, they would have to go through another cycle of recouping development costs and would only start making a profit after that.

From the original premise of a sick aerospace industry, one can begin to appreciate the commercial providers' position. If there's no requirement from customers for new developments, companies will not expend capital toward such developments. If there's no money, no new jobs will be created or new people be required. This suggests that if there is to be change, government must step in.

Houston, Do We Really Have A Problem?

The congressionally mandated Commission on the Future of the United States Aerospace Industry was established to investigate all aspects of aerospace: air and space, civil and military. After a lengthy data collection and deliberation process, the commission presented its final report in November 2002. One of the commissioners, Tom Buffenbarger of the International Association of Machinists and Aerospace Workers, commented recently that the recommendations have not caught the attention of policy makers.

If Congress goes to the trouble of commissioning a panel, members must think there's something seriously wrong; such action also implies they think something can actually be done about it. But one reason for a perception of nil action may be because there really is nothing that can be done. Why do some think that we can revitalize the aerospace industry and create jobs? Is it a possibility that maybe, like the manufacturing industry, these jobs have been relocated elsewhere and that it's now just a matter of dealing with the situation as best we can? The U.S. government could sink large amounts of money into the industry to prop it up, but this is probably not very likely. In the new era of globalization, many countries have found they can no longer shield their economies through protectionist policies if they are to become internationally competitive.

The Current Market

So what is the size of the aerospace employment market at the moment? Figure 1 shows that as of the year 2000 the aerospace workforce had been reduced to a little under 800,000 in the United States and to around 430,000 in the European Union. More recent figures indicate that the aerospace workforce probably fell to just below 580,000 in the United States and to around 408,000 in Europe by 2002. In sum, the United States has lost some 600,000 scientific and technical aerospace jobs since 1991.

Despite the large volume of evidence suggesting the industry is in a dire state, there exist studies that do not share this view. The RAND Corporation released a study this year that concluded: "Despite recurring concerns about potential shortages in scientific, technical, engineering, and mathematics personnel in the U.S. workforce, particularly in engineering and information technology, we did not find evi-

dence that such shortages have existed at least since 1990, nor that they are on the horizon." This study, which used figures up to the year 2000, represents a completely different view from the commonly presented one. What I believe this view highlights is that it's not a shortage of people that's the issue; for many, even though the industry is in a bad state, the romantic notion of working on a space project is still a very powerful attractor and ensures that enthusiasm for the industry remains. Rather, there is a shortage of jobs and hence the need by those who want to enter the industry to have the right skill sets.

The Impact of Business Restructures

Shifts in focus among aerospace product and service providers and users are prompting changes in professional skill requirements. Until the late 1990s, companies provided their launch vehicles and other pre-packaged goods and services to customers on an as-is basis, meaning the focus was on the good or service, not the customer. The situation now, however, is that customers don't want companies to sell them equipment; they now want providers to supply solutions that meet their needs.

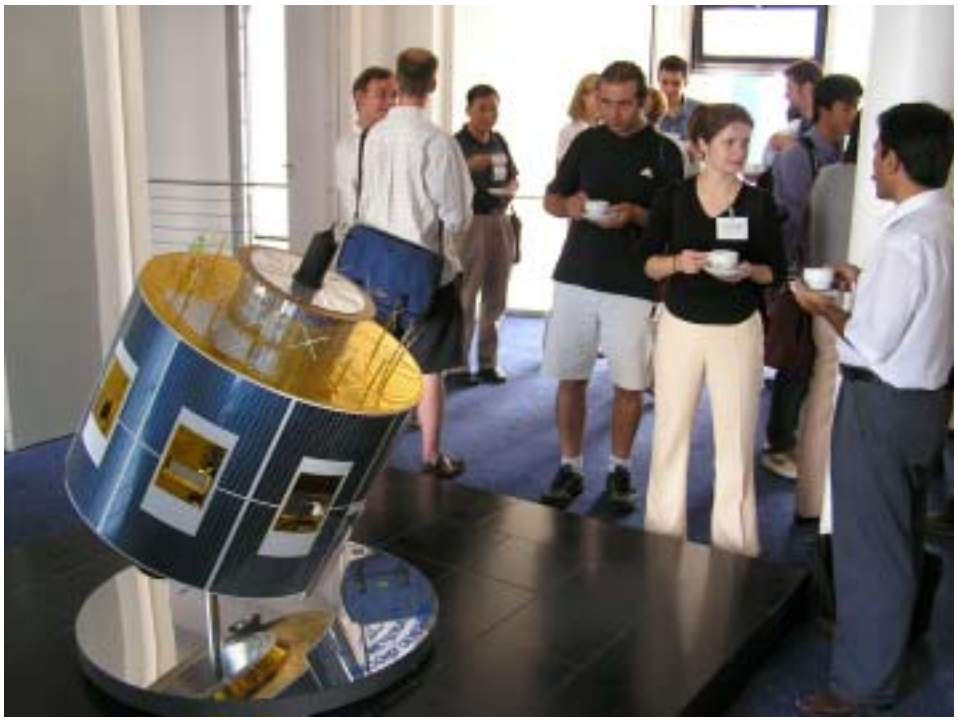
This change has been most evident in the military world. In the past, one generation of military aircraft was superseded by another in an action known as a platform replacement: a new aircraft was simply put in place of the old one. Today, clients don't just want a replacement aircraft, they want a replacement *capability*. What that means is that satisfying the capability an aircraft previously provided may now take an aircraft, a ship, and a few unmanned aerial vehicles. In the space world, the same thing is occurring. Customers don't just want a launch vehicle: they want an end-to-end provider that gives them the solution for putting a certain payload into space.

Companies who do this now need a new breed of employee because their focus has changed. They now require someone who can focus not just on the platform but on the far bigger goal of the solution that includes the platform as a subset. This does not mean they can bypass technical knowledge—they will always need engineers who know about the technology—but it means that they want people who can think in strategic terms and see the big picture. Companies are after people who can see across multidisciplinary boundaries, and part of this starts with thinking in systems terms.

Valued Skills

Systems thinkers take a structured, logical approach and break tasks, ideas, and concepts into their sub-components. They look at different capabilities, how they link together, and what happens at the interfaces. Systems thinking is everywhere, as manifested by the Aldridge Commission's recent advice that NASA follow a "system-of-systems" approach in its pursuit of President Bush's new space exploration agenda. No matter where you look in the aerospace world, companies are after systems thinkers.

The new market dynamics also mean companies need to be more responsive to emerging and new markets. As a result, there is a growing need to hire technically minded people who also possess a proactive, entrepreneurial mentality. This disposition can be independent of the context: one does not have to work in a private industry to exhibit entrepreneurial traits. Entrepreneurship involves making things happen by calling on a wide range of different information sources and networks and being innovative and creative in solving problems. Still other credentials can help budding aerospace professionals develop skills highly valued by potential employers. Involvement in a professional society is an invaluable way of preparing for entry into the workforce, not only allowing students and young graduates to build their networks and find out what's happening in the industry but also giving them the ability to talk with senior figures with



Networking with those already established in the aerospace sector can help students and young professionals learn about business trends and employment prospects in the field. (Source: International Space University)

whom they would not normally have the opportunity to interact. Professional societies form the bridge between universities and industry and allow students to be aware of issues when entering the workforce for the first time. Society memberships also allow communication and presentation skills to be improved in settings that will not incur professional repercussions.

Finally, aerospace professionals may consider pursuing Master of Business Administration (MBA) degrees. An MBA has seemed to be the logical choice for people wanting to color their technical backgrounds with business and management experience. But a word of caution is in order: timing is everything. Undertaking an MBA with little experience in the workforce can be inappropriate as it requires an ability to put into practice, or at least see the functioning of, concepts taught in a real work setting. It's probably a good idea for one to get a few years of experience before considering an MBA.

For many, even though the industry is in a bad state, the romantic notion of working on a space project is still a very powerful attractor and ensures that enthusiasm for the industry remains.

Conclusion

While it is not unambiguous that there is trouble in the aerospace industry, it is clear that the field is experiencing a large amount of turbulence. Ironically, the areas we most associate with the space industry tend to be experiencing the least growth. With the industry at the lowest point it has been in a very long time—perhaps ever—it is understandable that those wanting to enter the industry for the first time approach it with a sense of trepidation. Nonetheless, there's no shortage of people, although there is a shortage of those possessing the right skill sets.

Many view the aerospace industry as being one of dwindling opportunities, but it can also be viewed as the provider of new ones, vastly different from those offered in the past. ■

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Space Exploration: An International Endeavor

The value of international cooperation cannot be underestimated for established national space agencies working towards scientific goals—or for young professionals eager to improve their skills and make meaningful contributions to the aerospace field.

by Srimal Wangu Choi

In his January 14, 2004, speech on the vision for space exploration, President Bush stated: "We'll invite other nations to share the challenge and the applications of this new era of discovery [which] is a journey, not a race, and I call on other nations to join us on this journey, in a spirit of cooperation and friendship."

Indeed, there is a rich array of nations with which partnering may be an option. A brief glance at recent news headlines reveals: *China Starts Development of Its First Lunar Exploration Craft*; *India and Brazil Sign Agreement for Cooperation in Space*; *Europe's* SMART-1 *Leaves Earth on Long Journey to the Moon*. Many governments around the world are becoming active in space exploration pursuits.

World governments have worked together on space projects before. In doing so, they have faced many hurdles, such as competitiveness, non-proliferation issues, and changing political climates. These considerations make long-term commitments challenging. Currently, heightened national security concerns have divided nations even further, encouraging them to work autonomously to a greater extent.

I have had the privilege of working in various international and intercultural environments, through the International Space University and the Space Generation Advisory Council. Through my experiences I have learned that despite the challenges, there are many benefits, practical and intangible, to international cooperation. For this reason, I believe our space exploration initiative can benefit greatly from collaboration and cooperation with other countries.

In 1999, I participated in the International Space University (ISU) Summer Session Program. That summer it was held at the Suranaree Institute of Technology in Nakhon Ratchasima, Thailand, which is located 250 kilometers northeast of Bangkok. The ISU, which began at the Massachusetts Institute of Technology in 1988, is a non-profit organization that provides graduate level programs that are international, interdisciplinary, and intercultural in their scope. From its main campus in Strasbourg, France, ISU moves its ten-week summer session to a different location each year. This change in venue provides a truly international and intercultural environment for the participants. ISU offers three academic programs tailored to the needs of post-graduates and professionals in the space sector and those who wish to work in space-related fields: the two-month Summer Session Program (SSP) and two eleven-month masters programs: Master of Space Studies and Master of Space Management.

The author creates a Thai traditional decoration during an International Space University "culture night" at the 1999 Summer Session Program. (Source: International Space University)

I was one of eighty-eight students from twenty-four countries in the 1999 SSP. My fellow students at the SSP came from backgrounds as diverse as law, medicine, engineering, business, and social sciences. Some were graduate students, while some were well established in their careers with corporations, institutions, and space agencies around the world. We all attended the same four weeks of core lectures on a variety of space-related subjects given by world experts in their fields. After a half-day exam, we chose which of two group design projects we wished to focus on during the remaining six weeks. I worked on a project entitled "Strategies for Human Exploration Away from Earth."

Since 2002, I have participated in the Space Generation Ad-

In October 2002, the Space Generation Advisory Council convened the Space Generation Summit, which brought together approximately two hundred international young delegates to develop and contribute a youth vision of space to the World Space Congress. (Source: Space Generation Advisory Council)

visory Council (SGAC) in support of the United Nations Programme on Space Applications. SGAC formed as part of UNISPACE III in 1999, when alumni of the International Space University organized and convened the Space Generation Forum (SGF). The aim of the forum was to express the visions and perspectives of youth with regard to future space activities. Of the ten recommendations from the SGF technical report that were accepted by the United Nations, five were integrated into the Vienna Declaration output of the United Nations conference. One of the recommendations was "to create a council to support the United Nations Committee on the Peaceful Uses of Outer Space, through raising awareness and exchange of fresh ideas by youth. The vision is to employ the creativity and vigor of youth in advancing humanity through the peaceful uses of space."

The goal of this organization is to develop and maintain a fruitful relationship between young people and the United Nations Committee on Peaceful Uses of Outer Space and other space experts. SGAC's vision is "to enable and promote a continuous and interactive dialogue on space-related issues between the United Nations and young people of the world, and to further enable creativity, enthusiasm, and vigor of youth that shall be used to advance humankind through the peaceful uses of outer space."

> Through my international experiences I have gained a better understanding of the fact that we are all humans working together toward a vision of a better future.

As North American representative of SGAC, I have had the privilege to work with my international counterparts on a biweekly basis. I have noticed that as an American, it is easy for me to expect that my international teammates will conform to my cultural norms: speak English, know about my space program and its vision, understand "where I'm coming from"—and even know what my idioms mean. It is easy for me to proceed with this status quo and take the easiest path, and not go out of my way to understand where *they* are coming from.

This mindset, however, can lead to misunderstandings and missed opportunities. For example, at the ISU summer session, a Japanese team member of my project group was quiet and often seemed to defer to American, Canadian, and European ideas. It was only later, when he requested some dedicated time to formally address the group, that we realized he had an enormous amount of technical expertise to contribute to the project. He had not spoken up during informal discussions because he did not want to be perceived as impolite. Our lack of understanding of his Japanese culture almost prevented us from incorporating some excellent engineering design ideas into our group project.

Learning to work in an intercultural team provides additional benefits. International collaboration can provide a spark of creativity that leads to new approaches to problems. A classic example is the story of Dr. Edward Deming. After World War II, Dr. Deming traveled from the United States to Japan to help rebuild the country. While he was there, he was invited to give lectures on his statistical quality techniques, which were all but ignored in the United States. His lectures were very popular with Japanese executives, who already believed in *Kai Zen*, a Japanese concept that means "continuous improvement." By adopting Dr. Deming's theories, many Japanese manufacturing companies were able to produce high-quality products at reduced costs. This allowed them to eventually beat their American competitors.

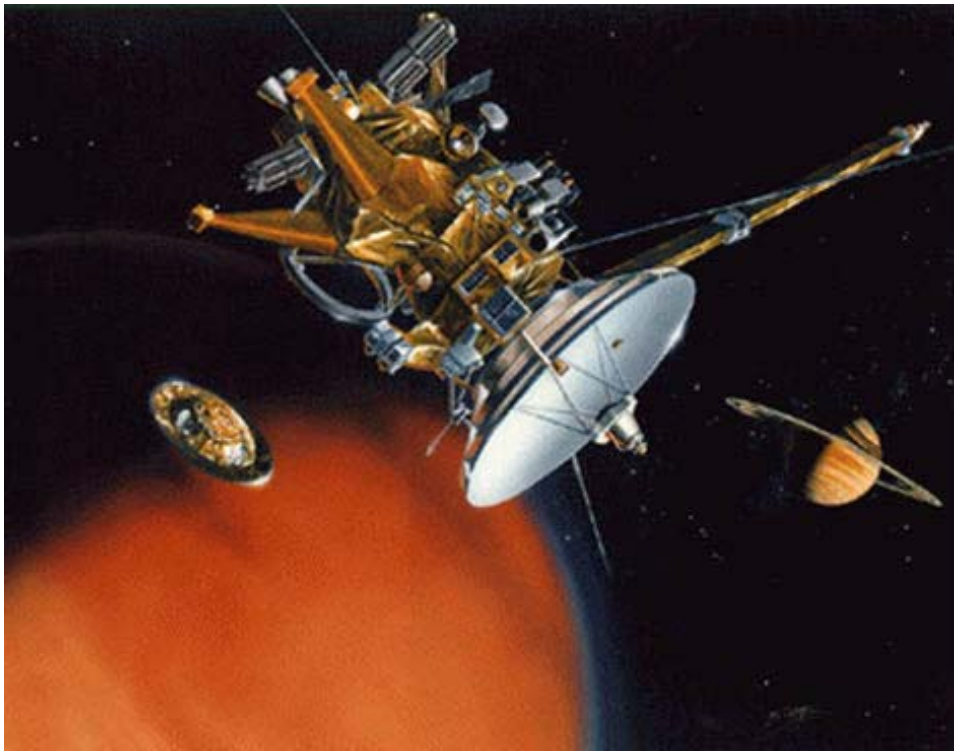
Collaborating and communicating with international partners has the additional benefit of providing a spark

of friendly competition. The progress of other countries in their outer space exploration efforts can present additional impetus for the United States to continue to excel in its space exploration projects as well as to seek out other countries as partners on exploration initiatives.

The European Space Agency already has *Mars Express* spacecraft in orbit around Mars, and *SMART-1* is currently en route to the Moon. Both are part of the European Space Agency's long-term Aurora solar system exploration plan, which involves human and robotic space flights. The Indian Space Research Organization has allocated funds for a lunar mission in 2008 and is thinking about a Mars mission thereafter. India has invited other countries to participate in the lunar mission and reports that Canada, Germany, Russia, and Israel have expressed interest. China has announced a program to launch a satellite to orbit the Moon in 2006, land a probe on the lunar surface in 2010, land a rover there in 2012, and collect lunar samples using a robotic spacecraft by 2020. The Japan Aerospace Exploration Agency plans to launch the *LUNAR-A* probe, which is intended to study the origin and evolution of the Moon (the launch was recently delayed).

Finally, working together creates understanding and friendship with people of other countries and cultures. Through my international experiences I have gained a better understanding of the fact that we are all humans working together toward a vision of a better future. Already the United States and other nations have signed hundreds of scientific and technological agreements and have ratified several treaties preventing conflicts in space and supporting space explorers. Since the beginning of the space age, countries have worked together to explore space for the benefit of all humanity.

As we in the space industry work toward implementation of the new space exploration initiative, I believe it is very important to incorporate international cooperation into the vision. In the grand scheme of things, isn't this what space exploration is all about? As the Apollo 11 lunar landing vehicle plaque commemorating the first landing of humans on the Moon reads: "We came in peace for all mankind." ■



The Cassini-Huygens *mission to explore Saturn is an example of international cooperation at its best. NASA provided the* Cassini *spacecraft, the Italian Space Agency furnished the high-gain communication antenna, and the European Space Agency supplied the* Huygens *probe, which will plummet into Titan's atmosphere later this year. Already, the mission has revolutionized scientific understanding of the ringed planet. (Source: NASA/JPL/Caltech)*

Srimal Wangu Choi **is currently the Space Generation Advisory Council representative for North America and is active in the ISU and NASA Academy alumni organizations. Srimal works for Orbital Sciences Corporation and resides in Arlington, Virginia.**

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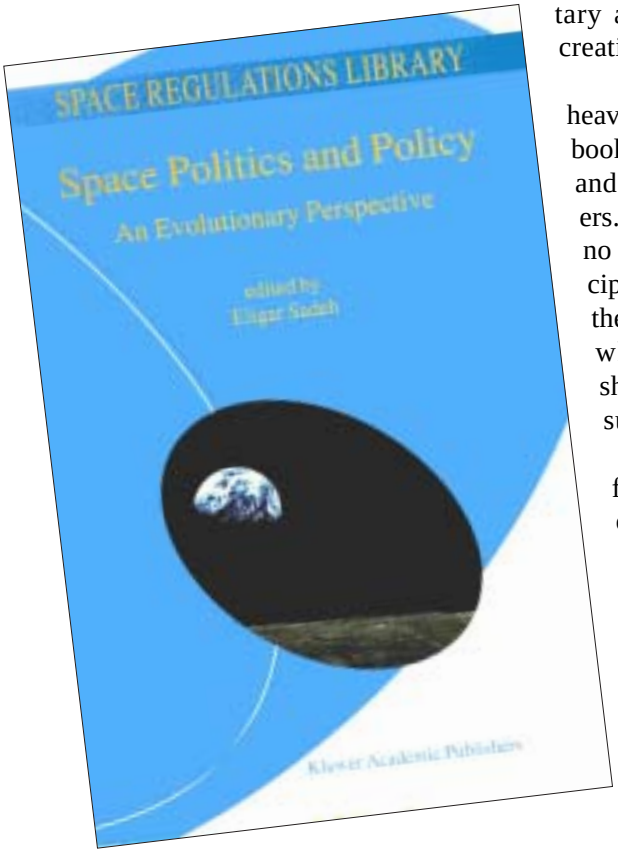
Space Politics and Policy: An Evolutionary Perspective

Reviewed by Mark Williamson

Space Politics and Policy: An Evolutionary Perspective, edited by Eligar Sadeh. Dordrecht: Kluwer Academic Publishers, 2003. 520 pages. ISBN: 1-4020-0902-X. $65.00 (paperback).

There are many of us who would like to think that space exploration is enabled purely by science, technology, and the desire to explore strange new worlds. In reality, however, its missions and applications are shaped and governed by politics, policy, and money.

This book is a recognition of that unpalatable truth. In addition to providing a detailed analysis of space policy history, it explores the role of politics, law, ethics, economics, and a multitude of other scientifically "soft" subjects that have just as much bearing as the physics of ion propulsion on whether we ever get to live on Mars. The late Carl Sagan was clear on the point: "Governments do not spend vast sums just for science, or merely to explore. They need another purpose, and it must make real political sense."



The product of more than a dozen contributors, the book has two main themes. First is the evolution of space policy in its response to dramatic political events, such as the launch of *Sputnik 1*. The other theme is space policy's role as an integral part of public policy in an international framework, addressing, for example, its military applications and its role in creating economic wealth.

Some of the chapters are heavy going, since this is a textbook aimed primarily at students and professional decision makers. On the other hand, there are no complex equations and indecipherable diagrams to interrupt the flow, so there is no reason why any interested person should not gain access to the subject.

Additional access is afforded via sections at the end of the book. Rather than adding references to the end of each chapter, the publisher has opted to include a dedicated section for chapter notes which runs to a hundred pages. While most of the notes are standard references, a few are more than a page in length, forming essays in their own right. As befits a book of this type, it also has a comprehensive, twenty-five-page index.

While economists write of "contingent valuation" and policy experts of "utilitarian doctrine," such jargon is kept to a minimum, and many of the chapters offer a deep insight into their subjects. In fact, some of them—such as "Space and the Environment" and "Ethics and Off-Earth Commerce"—push the boat into relatively uncharted waters. Does space exploration risk contaminating other planetary bodies, perhaps even destroying the forms of life we are trying to discover? Equally, does it risk returning some unknown pathogen to Earth and destroying the human race? These and other questions regarding the effects of our space policy are among the important considerations touched on in the book.

And I say "our space policy" advisedly, since all except one chapter have American authors. Surely a book such as this, on a subject so broad and internationally-based, should make more of a nod to international space policy than a single, eighteen-page chapter translated from a French original. After all, the responsible exploration of those "strange new worlds" rests with all spacefaring nations. Perhaps there is a little more evolution to experience before we have a true perspective on the many, interconnected issues of space policy. ■

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

The International Space Station: From Imagination to Reality

Reviewed by Mark Williamson

The International Space Station: From Imagination to Reality, edited by Rex Hall. London: The British Interplanetary Society, 2002. 160 pages. ISBN: 0-95065-976-2. $46.00/$37.00 members (paperback).

Everyone reading this review knows something about the International Space Station (ISS), and many will have actually seen it. It is, after all, one of the brightest points of light in the night sky. But only those directly involved in the project will know as much about the ISS as there is to learn from *The International Space Station: From Imagination to Reality*.

In addition to a module-by-module exposition of American hardware, it covers the background of the less well known Russian modules and their origins in the defunct *Mir 2* program. There are also chapters on the space shuttle missions to the ISS, the space station crews, and the scientific research conducted in orbit by those crews.

The tone of the introduction is surprisingly forthright but hits the nail on the head for many space watchers: the ISS is a project that both inspires and bores people. It is inspirational because it has brought so many nations together to design, build, and crew the station, but it is boring because one day of station news is very much like another: the ISS no longer grabs the headlines. It is also inspirational in the sense that it shows us what large, cooperative space missions of the future—such as missions to Mars—could be like but boring at the same time in its confinement of crews to low Earth orbit, constantly in motion but going nowhere.

This dichotomy highlights an inherent contradiction of space exploration and development: everyone in the space business wants space travel to be successful enough to become an everyday event; however, success—as illustrated by the ISS—makes space travel just another aspect of reality that we take for granted. This is part of the explanation for the book's subtitle, *From Imagination to Reality*, but it also reflects the motto of the publisher, the British Interplanetary Society (BIS), which has been proselytizing about space since its foundation in 1933.

As one would expect from the BIS, this book is aimed at the space enthusiast who craves information on his or her favorite subject; as far as the ISS is concerned, it fits the bill. Not only is the text crammed with information but also a number of useful tables and descriptive boxes supply additional data, down to the call signs used by ISS flight controllers. Many of the chapters come complete with lists of references, allowing the real information junkies to dig even deeper. One failing—a result of the book being a multi-author work, no doubt—is the lack of an index, and this is something the publisher might like to reconsider for a second edition. There are also a number of spelling mistakes, which is inexcusable in the era of the computer spellchecker.

On the plus side, the book's numerous color photographs are well produced and make for an attractive package. More importantly, they give a good impression of what it must be like to live and work both inside and outside the station. From a photographer's point of view, the light and clarity in low Earth orbit is little short of stunning, as some of the pictures in the book illustrate. One understated example is a shot of a materials experiment back-dropped by a sunrise that could have come from an artist's airbrush—something many of us would give an eyetooth to see firsthand.

The ISS itself is still a work in progress, and this book is intended to be the first in a series that will document its construction and operation. As we squint up at the sky for a glimpse of that slowly moving point of light, we must hope that it, too, will be simply the first in a series of international space stations. Until then, this book will help to keep the spark of imagination alive. ■

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

Space 3G

In order to move beyond low Earth orbit, a new generation must take up the torch of exploration. But will this generation—my generation—be ready to accept the challenge?

by Sarah R. Ramsey

Regardless of whether you reference *Logan's Run*, any number of *Star Trek* episodes, or *Babylon 5*, the idea of passing the torch from one generation to the next is older than science fiction itself. Humans have only been active, directed explorers of space for about five decades. In that short time, three distinct generations have taken up the call to explore space. As a member of the newest generation, I believe it is time for us to consider what we will do as that torch is passed to us. How do we plan to finally move the human race beyond low Earth orbit (LEO)?

The first generation founded active space exploration. They gave us astronauts, the Moon shot, *Voyager*, and NASA. The second generation grew up watching the United States go to the Moon and became the scientists, engineers, and astronauts who designed, built, and flew the space shuttle and space station. They also sent us back out into the solar system, sometimes spending an entire career devoted to one or two wonderful missions like *Galileo* or the Hubble Space Telescope.

My generation, the third generation, grew up knowing there were footprints on the Moon, even though we never witnessed anyone actually going there. For most of us, LEO is our backyard, and there have always been space shuttles and stations. We all wanted to go to Space Camp (raise your hand if you wanted to go because you thought you might get stuck on an accidental shuttle launch with Kate Capshaw!). The Russians have always been our partners, and NASA has always had budget problems. We grew up on Tang, teachers in space, Star Wars, rogue computers, and lizard aliens that looked like humans. We take for granted that satellites route our cell phone calls and pagers, give us twenty-four-hour-a-day weather updates, and can read the license plate of a car on the ground.

We are the LEO generation. We've never known anything different.

As with any new generation, some legacies will be passed down to us, and some unforeseen goals and opportunities will come our way. We have many paths from which to choose and just as many opinions on which direction to go and how to get there. But as we begin influencing the direction of policy and missions, will we be content to simply follow the lead of past generations?

America has a grand new vision for space exploration. While the details are still being defined, one thing is certain: it is my generation that will bear the largest portions of both the work and the cost. This is not a complaint. I believe we are willing to do both, as long as we are actually accomplishing a goal.

According to the Entertainment Software Association, computer and video games sales totaled $7 billion in 2003, with more than 239 million games sold. The average age for game players is twenty-nine. Why are we willing to invest this much time and money into games? For people accustomed to living in a virtual reality, we realize a greater sense of accomplishment from building a virtual planetary colony than watching a launch of the space shuttle on the evening news.

Computer games like "Civilization III" offer players virtual training for space exploration missions, but whether and when actual space travel becomes a possibility for the masses depends on the will and commitment of the rising generation of explorers. (Source: Atari/Firaxis)

Video games allow us to play the first-person role, a phenomenon that echoes throughout today's popular culture. In the past, people were content to

live vicariously through their heroes: movie stars, soldiers, astronauts. Today, our favorite games are first person, reality shows top the charts, and anyone can be a published author on the internet. We don't want to watch; we want to *do*.

For all our reputation as slackers, my generation does not have a problem with disinterest. Instead, we have too many outlets for our interest. Call it Attention Deficit Hyperactivity Disorder if you like, but we live in a put-up-or-shut-up world. If you do not keep our attention, we'll find something else that will. It is not impatience; anybody who has ever played the computer games "The Sims" or "Civilization" can tell you that some things take time, and it pays to think in the long term. In other words, it is not the timeline that matters. It's where we end up and what we do along the way.

Memoirs from the people who won the space race in the 1960s say they accomplished what they did because nobody told them it couldn't be done. We carry the same enthusiasm for exploration as those who have gone before us. But have we been conditioned to the thought that space is too hard, that it cannot be done? Or do we still believe that, given commitment and hard work, nothing is impossible?

We carry the same enthusiasm for exploration as those who have gone before us. But have we been conditioned to the thought that space is too hard, that it cannot be done? Or do we still believe that, given commitment and hard work, nothing is impossible?

We have the ability to shape the future; there is no destination out of our reach. What can we accomplish? What will be our legacy? Will we finally establish a human presence beyond where we've already been, or will we become so caught up in the destination that we lose sight of the journey? It's our future. Let's go do something about it. ■

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2005 CanSat Competition Announced

AAS, in cooperation with other organizations, is sponsoring a new competition that will allow college student teams the opportunity to participate in a hands-on space design program at an affordable cost. The competition involves writing a mission proposal, generating design documentation, and launching a "CanSat" to an altitude of 1.6 kilometers (one mile). The requirements for a CanSat are that all components of the payload must fit inside a standard soda can. Missions have been designed for both the undergraduate (rookie) and graduate (advanced) levels, and the deadline for applications is November 30, 2004. The launch will be held in the desert outside of the San Diego area in early June 2005. For additional information, see www.cansatcompetition.com.

Too Many Minds: Achieving the Right Engineering Mix

Aerospace projects are bound to benefit from the expertise of system engineers...but it's quality, not necessarily quantity, that counts.

by Jose J. Guzman, Ph.D.

If you have seen the movie *The Last Samurai*, you will likely recall a scene where Tom Cruise's character is struggling in a sword practice with one of the samurai. A younger samurai stops him and tells him "too many minds"—he is thinking too much about what he is trying to achieve. Just do it, go for it, the young samurai says.

Safe operation of complex systems like the space shuttle requires systems engineers to be able to visualize and understand not only the "big picture" but also fine details. (Source: NASA/Kennedy Space Center)

"Too many minds" also might be a good description for what is happening in the aerospace business nowadays. In this case, the proliferation of the so-called "systems view" and myriad processes, in both industry and the government, appear to be weakening the engineering practice. The users of the systems view—systems engineers—tend to apply deductive reasoning and analytical tools to analyze and trade options to develop and integrate system concepts. They are no doubt an important part of an engineering project. But, if project managers do not select their systems engineers carefully, the proliferation of systems engineers and the focus on the systems view of projects could lead to a weak understanding of the fundamentals required to make an engineering project successful. In fact, projects and organizations will buckle when there is too much weight at the top. It is, therefore, important to have experts in each of the subsystems to strengthen the engineering foundation of the project.

I cannot help but wonder if this systems or process view of engineering was one of the contributing factors for the *Columbia* accident. Was it that too many people were thinking about the "big picture" and forgot to pay more attention to the engineering details? It is, of course, easy to criticize, and in hindsight everything always looks clear. But paying attention to details in complex systems such as the space shuttle is exactly one of the many hats that the systems engineer must wear. Understanding what requires more investigation and what can be considered a "closed item" requires experience and subsystems expertise. It also requires being able to ask important questions and figure out when the pieces of the puzzle are not falling in place. Hence, it is extremely important that engineering organizations choose their systems engineers and project managers very carefully.

A good systems engineer will have direct knowledge of at least two or more aerospace subsystems and will most likely have ten or more years of project experience. This experience and cross-technology expertise is often obtained by years of working in the field and moving among different subsystems. A good, solid engineering education is the foundation that provides the analytical engine: it helps the engineer to work on the actual engineering details that make the difference between success and failure in individual subsystems. Creativity can be cultivated but not really taught. Therefore, aerospace systems research and development organizations should provide havens for creative individuals to unleash their full potential. Properly channeled, these individuals will make their organizations grow and shine. Otherwise, they may act like prima donnas and could end up weakening rather than enhancing the organization.

Academia is also aware of the growing problem of complex engineering systems and many schools are constantly improving their systems engineering curricula. A glance through some newspapers and technical magazines reveals that there seem to be many one-day or short courses in systems engineering. Is this a good idea? It is hard to say, but most likely not. Some similarities with Masters of Business Administration programs are readily apparent: for instance, programs seem to be popping out everywhere, with a lot of universities seeming to be after a quick buck. Of course, these programs might provide a good review or introduction to systems engineering concepts, and both industry and government organizations should keep an eye out for individuals that might benefit from such training. This investment is especially important as the complexity of engineering projects increases and we start approaching problems with a "system-of-systems" view. Indeed, just recently the President's Commission on Implementation of United States Space Exploration Policy recommended that NASA use this approach, integrating and synthesizing multiple systems and tasks, to manage the president's vision for space exploration.

It is clear that aerospace engineering organizations need good systems engineers. But these engineers should perhaps follow the Marines motto: "the few, the proud." Obtaining systems engineers with the proper mix of experience, cross-technology expertise, analytical knowledge, and creativity is a non-trivial task for any organization. Typically, senior engineers can help with the selection process. If the selection of these individuals is performed properly, engineering projects will run more efficiently. Another benefit of making a good selection is that organizations with systems architects could select individuals from the systems engineering ranks. These architects tend to be very creative individuals who develop long-term visions for their organizations. The analysis of technical gaps and the creation of technology investments are fundamental tasks of the architects.

Another point to consider is that no matter how good individual systems engineers are, they still need solid backing from the organizations that employ them. I believe that combining good systems engineers with the "skunk works" model of organizational operations could lead to the efficient development of complex aerospace engineering projects in record times. This recipe is often referred to as BASIC (see T.F. Hanson's 1987 book, *Engineering Creativity*), and it stands for:

1. Top level BACKING
2. AUTOCRATIC leader
3. SMALLEST possible number of people
4. ISOLATION from standard procedures
5. CREATIVE talent

Following the system-of-systems concept, then, perhaps the best approach to aerospace project management would be to embed BASIC within BASIC; that is, to select both the systems engineer and subsystem team leaders based on all the applicable BASIC tenets. With this approach, technical risk is mitigated since each subsystem has an expert and also runs more efficiently. Nevertheless, sufficient time should be allocated for integration of the different subsystems.

We all know we need systems engineers and systems architects for success in aerospace projects. The point is that perhaps systems developers should be more careful in who and how many people they select for these positions. A good mix of experience, cross-technology expertise, analytical knowledge, and creativity is needed in systems engineers. Finding qualified individuals is extremely important, especially as complexity increases and we move towards a system-of-systems view. However, no matter how good individual systems engineers are, they still need solid backing from their employers. I believe that combining good systems engineers with the "skunk works" model might be a good start. ■

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AAS Space Law Workshop a Success

American Astronautical Society

The AAS held its second International Space Law Workshop June 28-30 in Scottsdale, Arizona. The participants worked in three groups to tackle a number of topics including: the processes for developing space law; uniform implementation and enforcement of principles articulated in the United Nations space treaties; and how the international community has responded to issues such as orbital debris, spectrum allocation, space nuclear power sources, and space property rights. Please notify the AAS business office if you would like to be on the distribution list for the workshop's final report, which will be published this fall.

UPCOMING EVENTS

AAS Meeting Schedule

October 19–21, 2004
***Short Course: "The U.S. Government Space Sector"**
George Mason University
Arlington, Virginia
www.gmupolicy.net/space/

November 16–17, 2004
AAS National Conference and 51st Annual Meeting
Pasadena Hilton
Pasadena, California
www.astronautical.org
See page 4 for details

January 23–27, 2005
***AAS/AIAA Space Flight Mechanics Winter Meeting**
Copper Mountain Resort
Copper Mountain, Colorado
www.space-flight.org

**AAS Cosponsored Meetings*

February 5–9, 2005
28th Rocky Mountain Guidance and Control Conference
Beaver Run Resort and Conference Center
Breckenridge, Colorado
www.aas-rocky-mountain-section.org

March 29–30, 2005
43rd Goddard Memorial Symposium
Greenbelt Marriott Hotel
Greenbelt, Maryland
www.astronautical.org

June 2–4, 2005
***Student CanSat Competition**
Plaster City, California
www.cansatcompetition.com
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August 7–11, 2005
***AAS/AIAA Astrodynamics Specialist Conference**
Embassy Suites Resort
Lake Tahoe, California
www.space-flight.org

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