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

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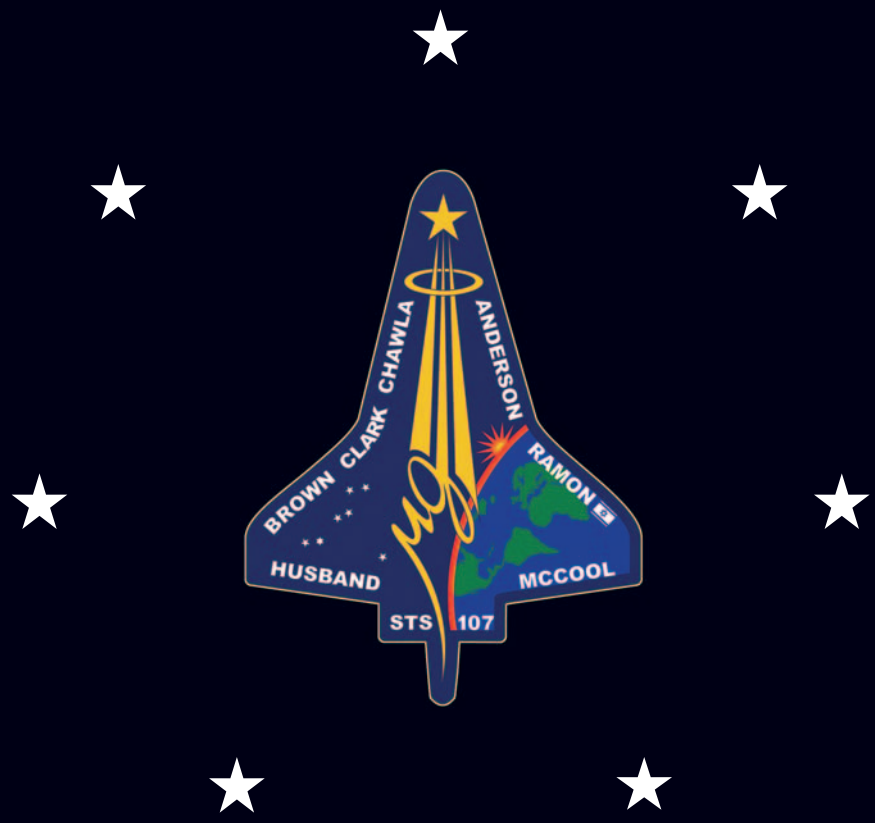

Columbia, we thank you.

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Joe Marino

"On January 16th, we saw our loved ones launch into a brilliant, cloud-free sky. Their hearts were full of enthusiasm, pride in country, faith in their God, and a willingness to accept risk in the pursuit of knowledge—knowledge that might improve the quality of life for all mankind.

Columbia's 16-day mission of scientific discovery was a great success, cut short by mere minutes—yet it will live on forever in our memories. We want to thank the NASA family and people from around the world for their incredible outpouring of love and support.

Although we grieve deeply, as do the families of Apollo 1 and Challenger before us, the bold exploration of space must go on. Once the root cause of this tragedy is found and corrected, the legacy of Columbia must carry on—for the benefit of our children and yours."

Statement from the families of the crew of STS-107 Space Shuttle Columbia

Are we alone?

Our mission is to explore, understand
and explain the origin, nature, prevalence
and distribution of life in the universe...

and we can't do it alone!

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

VOLUME 15, NUMBER 11 MARCH/APRIL/MAY 2003

MODULES

ON THE COVER:

Seven stars. Seven heroes. The crew of Space Shuttle Columbia, STS-107 will live in honored memory for their ultimate sacrifce.

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

NASA

PAYLOAD

HAIL COLUMBIA

Dan Brandenstein
President

The tragedy of February 1st, once again, highlights the risks and difficultly of exploring space. I think most people, including astronauts, think that the launch and ascent phase present the greatest risks and it probably does when you consider the high temperatures, pressures, rotating equipment and amount of energy imparted into the orbiter. However, when one realizes that all the energy has to be dissipated prior to landing, it becomes obvious that the entry phase presents significant risks with an equally small margin for error or malfunction.

As I write this, six weeks later, the root cause of the accident is not yet known, but there is an enormous effort to find the cause, fix it and return to flight. I have been extremely impressed with the full range of the investigation; the cooperation of many government agencies, the focus of the leadership and the dedication and expertise of the many people involved. Based on the caliber and dedication of all involved, I am confident that the root cause will be determined, appropriate corrective actions will be taken to return to flight as soon as possible.

The crew of Columbia, Rick, Willie, Kalpana, Laurel, Mike, Dave and Ilan, were dedicated to the goals of space research and exploration and gave their lives in pursuit of those goals. They had successfully accomplished all the research objectives and I am sure were very satisfied with their accomplishments prior to the entry tragedy. This was evident from the mood of the crew during the early phase of the entry that we have seen on the video recovered from the wreckage. This accident reaffirms the fact that in space exploration the margin between success and failure is very narrow; and as has been the case so many times throughout history, great people have paid the ultimate price in furthering the cause of research and exploration.

Now, more than ever, is the time for the membership of NSS to step up our activity in support of our space exploration goals. We can do this by actively participating in the three **R's** … **R**ecruiting, **R**esponding and '**R**iting. **R**ecruiting new members makes NSS a more viable voice nationally. Washington decision makers are especially attuned to the size and visibility of organizations such as NSS. **R**esponding to an opportunity to be seen, heard or counted. NSS Headquarters has a number of recent initiatives that require a response to increase our visibility and support. I am sure many of the chapters have a wide variety of activities that could benefit from a proactive response from NSS members. Now is a critical time to '**R**ite any and all Washington decision makers, especially the ones that count on your vote. I am confident that all of our members will rise to the occasion to actively promote the NSS vision and goals.

Finally, I want you all to know what an honor it was to have been your President for the past four years. I accepted the position for two reasons, first I truly believe in continuing to push the boundary of human knowledge and understanding of the universe in which we live. Secondly, during all my years in the Astronaut office, I was amazed by the vast support of the Space Program across America, but by the very low visibility of this support. It always seemed to me the vast support came from the moms and dads of America that were not reactive in nature. I hoped that my participation with NSS could draw out some of that grassroots support for the Space Programs. Hopefully, I helped in a small way to accomplish that. Unfortunately, my "real job" requires additional time over the next couple years such that I didn't feel I could adequately participate in a leadership role. However, I am totally confident that NSS will make great strides forward in the future. Our new Executive Director, Brian Chase, came onboard in December running at full speed and hasn't broken stride yet. He has an outstanding background for the position and a wealth of great ideas to take us forward. Additionally, the dedication and foresight of the officers, Executive Committee and Board of Directors will direct NSS to bright future.

With every member's active support and participation and the outstanding leadership, I am confident that NSS will do more than takeoff (a slow gradual climb) … it will LAUNCH (a rapid ascent to great heights) … Ad Astra!

Joe Marino

NSS wants to hear your voice on the Columbia tragedy. Write *Ad Astra* with your thoughts.

Thank you.

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to the stars *ad*Astra
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GOOD-BYE COLUMBIA, AND WE THANK YOU

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

It began as an average day. But it quickly became something very different. Images of a fallen shuttle. A President speaks solemn, eloquent words, pledging to continue the unfinished space mission. Flags on a snow-covered White House slide down to half-staff. Children rise and sing the National Anthem, the common bond that unites the American people when darkness comes unexpectedly. Around the world, America's friends mourn for her loss. America's enemies celebrate.

All of this happened on that day when darkness fell on the space program.

On 28 January 1986.

The lost shuttle was *Challenger*, the grieving President Ronald Wilson Reagan, speaking the crafted cadences of Peggy Noonan. The promises made that snowy day were kept. Space exploration continued, out there, in astronaut Rick Hauck's words when *Discovery* returned America to space "where the blue sky turns to black…"

On 1 February 2003 it happened again, this time to *Columbia*. President George W. Bush became the latest Commander in Chief to pledge to continue space shuttle flight. And again we were all reminded, that spaceflight is dangerous and uncertain. And that, even in times as unsettled as these, there are heroes that fly that winged imperfect machine that is still the triumph of America's will and determination.

What will happen now?

This is a very different time than 1986. And this is a very different NASA in mourning today. It was precisely the trauma of the *Challenger* accident that would reshape the civil space agency and lay down the improvements that made the next 70+plus shuttle missions a success. Whatever happened in the skies above central Texas, one can only hope it was a unique combination of circumstances special only to this time and that shuttle. A legion of people, from contractor to government civil service labor to make these missions as safe as can be done with this equipment. We must have the hope that they have not been betrayed, as was the case 17 years ago, by bureaucrats or oversights. For what is at stake this time, as last, is the very future of human spaceflight itself. The American people will tolerate mistakes, or equipment failures, or a pure and simple accident. But after *Challenger*, they will not ever again tolerate deception in space matters. And none is expected, once this accident investigation finds the cause of this event. Sean O'Keefe and his team has promised America a full and fair and open investigation. And we should not only believe his pledges, but give his agency and its contractor community the chance to work through this process. We owe these seven astronauts (including a local home town boy named Dave Brown, from my community of Arlington, Virginia who attended Yorktown High).

Should the cause of the loss of *Columbia* be systems gremlins or mechanical failures not dreamed of, our pause along the pathways to space will most likely be brief and limited. And so it must be, for unlike 1986, there is a space station in orbit, partially built, wholly dependent upon the shuttle fleet for its assembly.

As we have designed it and planned it to be.

The shuttle's final legacy, in fact, is its ability to build out the station. Once we have fixed these ills, if you wish to honor the STS-107 crew, then we will need to, to put it plainly, get on with it.

With what I hope will be a minimum of naysaying, second guessing, and camera-crews following grieving families around as they rebuild their lives. After all, in 1986 there was no 24-hour cable television. It exists today, and already the wailing and handwringing has begun. I hope that in all of this noise we do not forget why we believe in all of this—the exploration of space by flesh and blood.

To improve our world, flight by flight.

To answer the call of the unknown with knowledge and information, one piece, one experiment at a time. Because a great nation must use space technology to build a better society. As we do. As it does.

All of this space exploration comes with a price. In dollars, on an annual basis it's about what the

military spends every week. In blood and treasure, it sometimes extracts from us our best, smartest, most dedicated souls. Whose work improves us and gives us honor.

We are informed by their example, and diminished by their loss.

So let us remember who they were, find out why they died, and keep moving forward. As we did on 28 January 1986.

And, with determination, we must begin to plan the transition from full shuttle dependence to some combination of, at first shuttles and the Orbital Space Plane, and then, a new, next-generation reusable launch system. For an RLV is the ultimate solution to the problem of reliable, dependable, and affordable U.S. access to space.

When the old century was young, an American President once looked across the national landscape and saw wonder and opportunity. But he cautioned his young country that while it was emerging into the world, our place on that stage—requiring honor, sacrifice, and bounty –would sometimes demand unexpected costs.

But, Theodore Roosevelt wrote, those costs, the price of exploration and daring, were worth the price. He wrote:

"It is the man in the arena of public life that we honor, whose face is marred by dust and sweat, and blood, who strives valiantly, who errs and comes short again and again because there is no effort without error and short-coming; but who does actually strive to do the deed, who knows the great enthusiasms, the great devotions, who spends himself in a worthy cause, who at the best knows in the end the triumphs of high achievements, and at the worse if he fails at least fails while daring greatly."

Theodore Roosevelt never saw a spaceship, but was the first American President to fly in an airplane. He was right in his observations then about striving and sacrifice. On that Saturday last February we sacrificed anew when darkness came again.

After a time, let us resume the striving.

And, therefore, Hail *Columbia* and her crew.

And thank-you.

Frank Sietzen, Jr.

A Eulogy for Columbia

By Lou Mazza

The loss of the *Colombia* crew is was both startling and painful in its suddenness. Our hearts go out to the family and friends in this time of sorrow. We will mourn their passing and hopefully remember their contributions to the brighter and nobler aspirations of our society and civilization. As questions are raised about where do we go from here, we can look to history for some answers. The streets of Edwards Air Force Base are named for the test pilots that gave their lives in developing the new aircraft and spacecraft of the 20th Century. Those test pilots pushed the envelope as they reached for the sky. When an accident occurred their sacrifice and accomplishments were honored, a street was named for them and their brethren flew ever higher and faster since this was the most fitting tribute to their efforts. We must dedicate ourselves to flying higher and farther (again to the the Moon and eventually Mars), in their honor.

On 8 May 1927 Nungesser and Coli, French Aviators, departed Paris for New York. The news startled Charles Lindbergh who was completing the checkout of his Ryan Aircraft monoplane. The French team went missing somewhere over the Atlantic and Lindbergh would race across the United States in record time. Linbergh joined Admiral Byrd and other flight teams who were assembled at Floyd Bennett Field on Long Island. On 20 May weather cleared and *The Spirit of St. Louis* departed for Paris and flew into history. The loss of the French aviators was acknowledged but the urge to explore and expand our horizons was not delayed.

Charles Lindbergh's achievement paved the way for other exploration and discovery. He became the toast of the town in New York. When he heard of a science teacher in Massachusetts who was developing a liquid fueled rocket he arranged for the Guggenheim Foundation to provide a $50,000 grant to Robert Goddard. Goddard would follow his dreams and develop his rockets outside of the desert town of Roswell New Mexico. Lindbergh would accept a job as advisor to the fledging airline industry and he would travel the world charting the air routes. He blazed the London to Australia air route and after he met and married Anne Morrow, the daughter of the US Ambassador to Mexico, he laid out similar airline routes in Mexico, Central America and South America. While flying over the Yucatan this newlywed couple spied and photographed the Mayan temples that peeked through the jungle canopy. A civilization, lost for 1000 years, had been rediscovered.

Charles Lindbergh's flights and discoveries were legendary. Yet on his deathbed "The Lone Eagle" said that he was blessed to have lived long enough to see another Eagle when it landed on the Moon! Humanity's urge to explore is an innate aspect of our romantic and intellectual well being. Our comrades will have their names added to the Apollo 1 and *Challenger* memorials. I do hope that we remember that those streets at Clarke City on the moon and Zubrinopolis on Mars would carry the names of *all* astronauts and aviators who have flown the final mile for all of mankind.

MISSION CONTROL

spacebeat
BY JOHN KROSS

what's up
BY ASTRO-USU

DODGING THOSE GREAT BALLS OF FIRE

Getting slammed by a kilometer-wide space rock—the kind that doomed the dinosaurs—is a little less dicey than once thought according to new research from asteroid hunters. However, they warned that close encounters of the worst kind with smaller meteors could still leave a deadly trail of destruction. "Most of our attention has focused on the bigger guys which can cause global damage, but the mean time of them occurring is about 700,000 years," said Peter Brown, an astronomer and author of a study published in *Nature*. "However, the smaller guys can cause significant regional damage and do it much more often," he cautioned.

Scientists using previously secret U.S. military satellite data estimated that a destructive impact causing a "Tunguska-like event" would occur an average of once every 1,000 years. That event cut a swath of destruction across Siberia when a meteor estimated to be 50 to 70 meters wide exploded in mid-air in 1908. Releasing the energy equivalent to a conventional hydrogen bomb, the explosion flattened trees and created a scar in the czar's backyard hundreds of kilometers across near the Tunguska River. Because the area was uninhabited, there were no deaths. However, "if a similar event took place over a densely populated area in the world today, the death toll could easily be many millions of people," predicted Robert Jedicke, an astronomer who wrote a companion article.

Present efforts have focused on detecting and possibly diverting asteroids much larger—a kilometer or more wide—that are known to cross the Earth's orbit. Objects of this size are thought to have caused global damage on a catastrophic scale, such as the death of the dinosaurs, when they collided with the Earth in the past. Nearly 500 such large bodies—astronomers believe the total number is twice that—have been identified. Various proposals, such as changing an asteroid's orbit by setting off atomic bombs on its surface, have been proposed to protect the Earth from cataclysmic collisions.

However, Tunguska-sized bodies would likely escape detection. "The most likely warning we would get about them would be no warning whatsoever," Brown said. "We'd only know about them after the satellites or some other device said they have hit." The chance of detecting smaller, but still nettlesome space rocks, may improve in the future if a recent U.S. proposal to build a series of three-meter telescopes with automatic monitoring equipment is adopted. These telescopes could scan the entire sky every few weeks looking for Tunguska-sized objects.

IN TOUCH WITH THE UNIVERSE

A new book of majestic images taken by NASA's Hubble Space Telescope puts the wonders of the universe at the fingertips of visually impaired space buffs. The 64-page book called *Touch the Universe: A NASA Braille Book of Astronomy* presents color images of planets, nebulae, stars, and galaxies embossed with lines, bumps, and other textures. The raised patterns translate colors, shapes, and other intricate details of the cosmic objects to allow visually impaired people to get in touch with the universe they cannot see. The raised images not only represent the outlines of stars, planets, and galaxies, but consistent patterns denote color and matter. Raised lines, for example, represent blue. Rings are illustrated with dotted lines, whereas wavy ones signify gas currents. Braille and large-print descriptions accompany each of the book's 14 photographs, making the design of this book accessible to readers of all visual abilities.

"I think this book will help the blind community to better understand the variety of objects in space," explains the book's author, Noreen Grice. "This book brings amazing celestial objects, seen with the Hubble Space Telescope, to the fingertips of the visually impaired, where they can better understand the universe and their place within it."

Touch the Universe takes the reader on a cosmic journey, beginning with an image of the Hubble Space Telescope orbiting Earth and then traveling outward, showing objects such as Jupiter and the Ring Nebula. The journey ends with the Hubble Deep Field, an image revealing thousands of galaxies billions of light-years away. NASA, which helped fund the book, and the book's publisher, the Joseph Henry Press, trade imprint of the National

Academies Press (publisher for the National Academy of Sciences), released *Touch the Universe* in November 2002.

Giants Get Gas Fast

New research suggests that protoplanets circling young stars can become bloated gasbags in a few hundred—not millions—of years. Getting gas fast is necessary, scientists say, because aspiring gas giants must survive the effects of nearby stars dispersing the gases. If the process takes too long, the gases will be dissipated by the radiation from those stars. "If a gas giant planet can't form quickly, it probably won't form at all," said astrophysicist Thomas Quinn.

The standard model of planet formation holds that the spinning disk of matter, called a protoplanetary disk, that surrounds a young star gradually congeals into masses that form the cores of planets. That process was thought to take a million years or so, and then the giants gradually accumulate their gaseous envelopes over perhaps another 1 million to 10 million years. But the new research, culled from a much-refined mathematical model, suggests that the protoplanetary disk begins to fragment after just a few spins around its star. As the disk breaks up, clusters of matter begin to form quickly and immediately attract the gases that form vapor shrouds around gas giants. "If these planets can't form quickly, then they should be a relatively rare phenomenon, whereas if they form according to this mechanism they should be a relatively common phenomenon," said Quinn.

The new model also explains why two other giant planets in our system, Uranus and Neptune, don't have gas envelopes like Jupiter and Saturn. At the time those planets were being formed, the solar system was part of a star cluster, and Uranus and Neptune were too close to a nearby star—one that has since migrated away—and therefore lost whatever gas envelopes they might have accumulated.

Hubble 'Weighs' Distant Planet

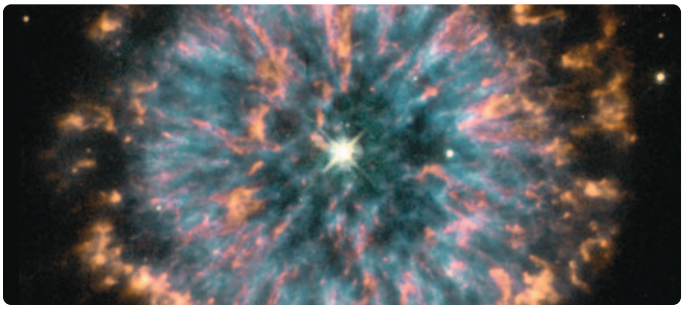
Astronomers using the Hubble Space Telescope have used a new measurement technique to make a precise estimate of the mass of a planet in another star system. The Hubble results show that the planet—dubbed Gliese 876b—is 1.89 to 2.4 times as massive as Jupiter, our solar system's heavyweight champion. Previous estimates indicated that the mass of the planet, which is about 15 light-years away, was between 1.9 and 100 times that of Jupiter's.

Gliese 876b is only the second extrasolar planet for which a precise mass has been calculated and the first whose mass has been verified using a technique called "astrometry." Dozens of planets have been discovered indirectly using the Doppler technique, but measuring a planet's spectral "wobble" can't reveal the angle of a planet's orbit. Therefore, estimating the maximum mass is difficult. The astrometry technique, on the other hand, measures the miniscule "wiggle" in the motion of a star caused by a companion object. From this celestial jiggle, researchers can estimate the shape of the orbit and pin down the mass of an extrasolar planet." There are a few more stars where we can do this kind of research with Hubble," said George Benedict, coauthor of a report in *Astrophysical Journal Letters*.

Determining the mass of more extrasolar planets could help astronomers answer many questions about how planets form. "When we get hundreds of these mass determinations for planets around all types of stars, we're going to see what types of stars form certain types of planets. Do big stars form big planets and small stars form small planets?" asked Benedict, a researcher at the University of Texas.

Orbital Space Plane Gets the Nod

The loss of the space shuttle Columbia has focused even greater attention on proposals to develop a



NASA

Left: Gases surrounging planetary nebula, NGC 6751.

new space plane capable of ferrying astronauts to and from the International Space Station. The space plane, which could be launched from Cape Canaveral aboard an emerging breed of rockets, was part of the space agency's Integrated Space Transportation Plan presented last year. Originally, the Plan called for deploying the space plane as a space station crew rescue vehicle around the end of the decade, and making it available to transport crews by 2012. NASA envisioned phasing out the space shuttle around 2020. However, the loss of Columbia has raised questions about how much longer NASA should rely on an aging shuttle fleet. Several observers believe Washington has no option but to accelerate the space plane program. "The real question is should you accelerate the [space plane] program and the related funding for a shuttle follow-on," said Gil Rye, a former director of space and intelligence programs at the National Security Council.

Release of technical requirements for the space plane were delayed temporarily following the shuttle accident, but were later issued virtually unchanged. At least some of the infrastructure to field a space plane is already in development. To get a boost to orbit, the craft could use launchers already being developed by Boeing and Lockheed Martin. That would save money by avoiding the cost of creating an entirely new launch system, as was done for the shuttle fleet. The two companies have new launch complexes on NASA and Air Force property at Cape Canaveral.

Boeing and Lockheed executives have been working with NASA to figure out what it would take to prove the rockets are safe to launch humans. "We have been working with them to try to look at different alternatives, but we've not been given anything officially as far as funding or a final decision," said Adrian Laffitte, director of launch operations for Lockheed's Atlas 5. "We're interested in exploring all different market possibilities."

Developing a space plane ensures that the road to orbit (and back) remains open in the event the shuttle fleet is grounded. Such a system would also allow the United States to end its reliance on Russian Soyuz spacecraft used for emergency escape by the three-person station crew. Versions of the venerable Russian three-seater have flown in space since the 1960s. However, the ships can stay on the station for only six months because their batteries and other systems degrade while docked to the station. The Russians are obligated to provide fresh escape pods through the spring of 2006, however, the Russians' largest space contractor, Energia, has said money problems could force it to stop building Soyuz.

China On "Long March" Toward Human Spaceflight

China recently parted its "Bamboo Curtain" and gave the rest of the world a peak into the communist giant's plans in space. According to state-run media, China is planning its first manned space launch later this year. If successful, China will join the United States and Russia as the only nations capable of sending humans into orbit. Such an expedition would represent both a scientific watershed and a public relations victory for China's military-linked space program. The Chinese government has long been enthusiastic about its space program, which it casts as a symbol of technological progress in a nation ascendant.

The announcements came as the latest unmanned Chinese craft, Shenzhou IV, orbited the Earth as a direct precursor to a manned flight. Shenzhou IV has all the facilities necessary for manned flight, and the Xinhua news agency reported that "taikonauts," the Chinese version of an astronaut, have been training. The next mission, Shenzhou V, will contain at least one "taikonaut" according to a report from China News Service. Shenzhou, which means "divine vessel," is modeled on Russian space technology, and can accommodate a three-person crew.

Taikonaut wannabes picked from the ranks of fighter pilots in China's air force have been training for several years. Any such pioneers would immediately become legendary figures in China, whose propaganda machine is always on the lookout for new demonstrations of patriotism. "The short-term goal is to send Chinese into space. The grand vision for the future is to explore space. Both are inspiring to the Chinese people," said Huang Chunping, chief commander of rocketry for the Shenzhou project.

What's Up?

BY ASTRO USU

Name	Date 2002	Launch Vehicle	Launch Site	Period (min)	Incl (°)	Apogee (KM)	Perigee (KM)
Eutelsat W5	20 Nov	Delta IV	Cape Canaveral	1436.1	0.1	35791	35782
Endeavor	24 Nov	STS 113	Kennedy	92.3	51.6	390	383
Astra 1K	26 Nov	Proton K	Baikonur	90.2	51.6	349	217
AISat 1	28 Nov	Cosmos 3M	Plesetsk	99.1	98.2	746	683
Mozhayets	28 Nov	Cosmos 3M	Plesetsk	99.0	98.2	744	681
TDRS-10	4 Dec 4	Atlas IIAS	Cape Canaveral	636.5	26.2	35793	421
NSS 6	17 Dec	Ariane 44L	Kourou	1431.82	0.06	35737	35669
Rubin 2	20 Dec	Dnepr	Baikonur	97.87	64.56	679	635
Latinsat B	20 Dec	Dnepr	Baikonur	98.08	64.56	702	632
Saudisat 1C	20 Dec	Dnepr	Baikonur	97.97	64.56	690	633
Unisat 2	20 Dec	Dnepr	Baikonur	97.76	64.56	667	636
Trailblazer	20 Dec	Dnepr	Baikonur	97.56	64.56	645	639
Latinsat A	20 Dec	Dnepr	Baikonur	97.66	64.56	656	638
Cosmos 2392	24 Dec	Molniya M	Plesetsk	715.93	62.86	39722	542
Cosmos 2394	25 Dec	Proton K	Baikonur	675.74	64.79	19137	19123
Cosmos 2395	25 Dec	Proton K	Baikonur	679.82	64.79	19335	19130
Cosmos 2396	25 Dec	Proton K	Baikonur	671.57	64.79	19135	18915
Shen Zhou 4	30 Dec	Long March 2F	Jiuquan	91207	42.41	337	331
Nimiq 2	30 Dec	Proton M	Baikonur	1435.77	0.11	35797	35764

November 2002

1 November: A Russian Soyuz rocket, which seemed to be in jeopardy after a crash, launched successfully to the ISS with a three-man team. The launch was initially planned for 28 October, but the mission was postponed for two days after a different Soyuz rocket exploded, killing one military soldier. The crew will spend 10 days aboard the ISS. They will carry a modernized command post aboard, which will serve as a rescue capsule for the next six months for the ISS's main capsule in the instance of an emergency.

12 November: The Space Shuttle *Endeavor* launch was postponed due to an oxygen leak. A leak was revealed in a pipe that transports oxygen to the spacecraft cabin. *Endeavor* will carry three astronauts, in additional to the normal four, to replace the three astronauts that are currently on the ISS.

16 November: The first journey of Boeing's Delta IV rocket was delayed due to technical difficulties. Small cracks were found in the new engine.

20 November: The Boeing Delta IV rocket, carrying the Eutelsat W5 spacecraft, launched successfully into Earth orbit from Cape Canaveral. The launch is Boeing's contribution to the Air Force Evolved Expendable Launch Vehicle (EELV) program. The satellite, which is designed to last over 12 years in a geosynchronous orbit, will supply communication and television services to customers in Western Europe and Far East Asia.

24 November: The shuttle *Endeavor* lifted off from Florida's Space Coast, carrying a new expedition crew and a new truss safely to the ISS. After delaying the launch for 12 days because of a leaking oxygen line, and then bad weather, *Endeavor* launched and will be nearly identical to the STS-112 flight. The fundamental objective is to continue building the ISS truss that will provide the foundation for the ISS' electricity-generating solar wings and heat-dispelling radiator panels.

26 November: A Proton K rocket upper stage failed, leaving an Astra 1K communications satellite trapped uselessly in a low Earth orbit. The delivery began successfully, with a triumphant launch from the Baikonur Cosmodrome in Kazakhstan. The Astra-1K satellite was slated to replace three Astra satellites currently in orbit and would have served as a spare for four others, in the 13-spacecraft constellation. The Astra constellation provides radio, Internet, and television service to European customers.

28 November: A lightweight Cosmos-2M rocket, carrying two 90-kilogram satellites, launched into orbit from the Plesetsk launch site. The first satellite is planned for research into building a navigation system. The other, called AISat-1, is the first sent to space as part of an eight-satellite disaster monitoring constellation.

December 2002

4 December: An advanced NASA communication satellite was carried aboard an Atlas 2A rocket from Cape Canaveral into Earth orbit. The launch is the last step of $800 million endeavor to further NASA's communication network by sending three new sophisticated TDRS spacecraft into orbit. The communication network controls efforts ranging from the ISS to the shuttle to the Hubble telescope.

11 December: A new Ariane 5 rocket, carrying a Hot Bird 7 direct-broadcast television satellite, failed approximately three minutes after its launch from the European spaceport in Kourou, French Guiana. The failure raises questions about the 12 January launch of ESA's Rosetta spacecraft, which will launch atop an Ariane 5 rocket. If Rosetta misses the 10-day launch window, the next launch opportunity is in 170 years.

13 December: An Australian satellite launched aboard an H-2A Japanese rocket from the Tanegashima Space Center. The launch marks the first time that a country from the international community has launched a rocket from Japan. Japanese officials are hopeful that this mission will improve Japan's commercial satellite launching industry. The FedSat satellite is expected to provide broadband Internet services to parts of Australia.

17 December: The Ariane 4 rocket successfully carried New Skies Satellites' NSS-6 spacecraft into orbit. The launch is one of the final Ariane 4 missions before the vehicle is retired for the larger Ariane 5. Coverage for commercial transmissions is expected from India through Asia.

20 December: A refurbished Yuzhnoe R-36M known as a Dnepr rocket launched from the Baikonur Cosmodrome. The Dnepr carried six small payloads.

24 December: A NPO Lavochkin-built early warning military satellite launched successfully on a TsSKB-Progress Molniya-M rocket from the Baikonur Cosmodrome.

25 December: A trio of Russian satellites was launched aboard a Krunichev Proton-K rocket from Baikonur Cosmodrome. The satellites will become part of the Russian military's Global Navigation Satellite System (GLONASS) navigation system. The system allows Russian military to identify their locations anywhere on Earth.

30 December: The Chinese Shenzhou 4 launched from Jiuquan and carried two dummy astronauts with equipment to observe the life support system. The next flight is expected to carry China's first astronauts.

International Launch Services enjoyed its first commercial launch of the Proton-M. With the Nimiq 2 satellite onboard, the rocket launched from Baikonur Cosmodrome.

Washington Update:

A view of Earth at sunrise from the crew cabin of Columbia.

The Columbia

By Brian Chase

NASA

Space policy was at the forefront of the national agenda in February in the wake of the loss of the Space Shuttle Columbia. And although the ongoing war on terrorism and the war in Iraq have since reclaimed the nation's attention, the behind-the-scenes policy debates about the Space Shuttle, access to space, and the future of human space exploration will continue for many months.

The Columbia was lost just two days before NASA was slated to deliver its FY2004 budget proposal to Capitol Hill, so that proposal has gotten very little attention during the course of the accident investigation. However, that budget contains significant shifts in focus for NASA. Importantly, it also represents the first substantial increase in NASA's funding in several years, going from $15 billion in FY03 to nearly $15.5 billion in FY04.

The long-awaited nuclear propulsion and power initiative, dubbed Prometheus, was unveiled and included a budget request of $279 million. Nuclear propulsion and power is viewed by NASA Administrator Sean O'Keefe as a critical element in a long-term space exploration architecture being developed by the agency, and he is drawing on the expertise of the U.S. Navy, which has operated nuclear powered vessels for several decades and has refined the technology to make reactors safer, more efficient, and more compact.

Additionally, NASA requested $39 million for the Human Research Initiative to study human factors in missions beyond Earth's orbit. While this funding level is a relatively small investment in this research area, it represents a shift in NASA policy. Under the previous Administration, NASA was not permitted to fund efforts looking at human space exploration beyond the International Space Station (ISS), and this program reflects O'Keefe's desire to map out an exploration strategy that includes both robotic and human missions.

In the space transportation arena, work is proceeding even as the Columbia investigation continues. NASA's FY04 budget request reflects the reality that the Space Shuttle fleet will be needed to complete ISS and perhaps beyond, and the request includes funds to upgrade the fleet and the ground infrastructure to improve safety, reliability, and performance.

However, NASA also recognized—even before the loss of Columbia—that backup options were needed to transfer crew to and from ISS. The Orbital Space Plane (OSP), for which $550 million is requested in the FY04 budget, is envisioned as that complementary capability, and the details of that program are still in the early stages. But the basic elements of the OSP program require the vehicle to be launched aboard an Evolved Expendable Launch Vehicle (Lockheed Martin's Atlas V and Boeing's Delta IV), carry 4 or more crew, be more maneuverable than the Shuttle while in orbit, and require less preparation time for launch than the Shuttle.

There is also interest among Capitol Hill staff and some in the aerospace industry to restore funding to the Alternate Access to Station (AAS) program, which had been slated for termination this summer. AAS was envisioned as a backup cargo capacity to ISS, and was being managed under the former Space Launch Initiative (SLI). AAS would have opened up competition for cargo delivery services, which makes it attractive as a means of increasing private sector involvement in ISS.

SLI has been refocused in the FY04 budget to include the OSP program and the Next Generation Launch Technology (NGLT) effort, which is funded at $515 million in NASA's FY04 budget request. NGLT includes research for next generation launch systems and is being closely coordinated with the Department of Defense (DoD) National Aerospace Initiative, which is also conducting R&D for future launch technologies.

Investigation

The NASA and DoD ties represent a new area of cooperation, particularly since relations between the two agencies has been tense ever since the development of the Space Shuttle. But recognizing that they shared common interests, NASA and DoD officials agreed that a partnership would be the best way to take advantage of the unique experience and expertise that each agency possesses.

One additional variable is a long-awaited White House review of U.S. space policy. Two studies have been started, one related to remote sensing and the other to space transportation. The space transportation policy review, which was ordered last summer as National Security Presidential Directive (NSPD) 15, is expected to reinforce the need to develop next generation launch technologies and to encourage greater cooperation among federal agencies. However, the formal review process has been put on hold pending the Columbia investigation.

Congress has begun its deliberations on the NASA FY04 budget, and there has already been one joint House-Senate hearing on the loss of Columbia. The OSP, space transportation, and the future of human space exploration will all be areas of debate in the coming months as Congress exercises its review of the President's budget request and determines spending levels, and NSS will be engaged with key House and Senate offices and committees throughout the 108th Congress.

Indeed, as you read this the first NSS Legislative Conference will be underway or have been completed in Washington, DC, which provides NSS members the opportunity to visit members of Congress and their staff to communicate the importance of human space exploration. A copy of the NSS presentation being used on Capitol Hill is available on the NSS website at *www.nss.org*.

The coming months will represent both significant opportunities and significant challenges for the space advocacy community. While we see some very positive developments in NASA's long-term planning—such as the nuclear propulsion and power initiative—there are still political hurdles to ensuring we have sufficient investment in critical areas such as next generation launch systems. Additionally, critics of human space exploration are already taking advantage of the loss of Columbia to press their case to end or severely curtail the human presence in space. NSS will be engaged throughout these policy debates to ensure your voice is heard and that we continue to push outward to open the space frontier.

Wake-up Call

By Hon. Ralph M. Hall

The nation's space program is going through challenging times. The loss of the Space Shuttle *Columbia* demonstrated once again that space exploration is not easy or free of risk. We are indebted to the brave women and men who are willing to put their lives on the line in pursuit of our national goals in space.

An investigation is now underway to determine the specific cause of the *Columbia* accident as well as any contributing factors. I hope that the Accident Board will be successful, and we need to give it time to do its job. I am not interested in assigning blame for the tragic events, but I do want us to find out what happened, fix whatever needs fixing, and then resume Shuttle flight operations. Our human spaceflight effort is an important part of America's future in space, and we should not walk away from it simply because it entails risk.

At the same time, I think the loss of *Columbia*'s crew should be a wakeup call. In the 17 years since the *Challenger* disaster, very little has been done to improve the odds of survival for Shuttle crews in the event of an accident. That troubles me. NASA needs to make a vigorous effort to reassess options for crew survivability systems for the Space Shuttle. Weight margins and other constraints that may have been limiting factors in the past may no longer be significant considerations now that the Space Station is largely assembled.

In a similar vein, I am troubled by the on-again off-again approach to the development of a U.S. crew rescue vehicle (CRV) for the International Space Station. Consistent with our international agreements, the U.S. *had* a program to develop a CRV. NASA and OMB walked away from the project two years ago, and now we are being told that we will have to depend on a new Orbital Space Plane (OSP) program—a program that is still just on paper—to provide a CRV, with the proviso that the OSP-based CRV will not be ready until the end of this decade. The logic behind these starts and stops eludes me.

The fundamental question we have to confront is whether we are willing to delay developing systems that could increase the chances for survival of our Shuttle and Space Station astronauts in the event of an emergency, or whether we instead should try to provide that extra protection as soon as practicable. I think that the responsible answer to that question is obvious, and I intend to work to focus attention on this issue in the coming weeks and months.

Rep. Ralph Hall, Fourth Congressional District of Texas, was elected to Congress in 1980, and is the ranking member on the Committee on Science, and former Chairman of its Space Subcommittee. He is also the senior member of the Energy and Commerce Subcommittee. He served previously from 1950 to 1962 as County Judge of Rockwall County, Texas, and in the Texas State Senate from 1962 to 1972. A Rockwall native, Rep. Hall was a Navy carrier pilot during World War II, earned his L.L.B. from Southern Methodist University, and is married and has three sons and five granschildren.

The Importance of Space Exploration

By U.S. Sen. Sam Brownback

Over the past 100 years, America has soared from the first flight of the Wright Brothers in 1903, through the vision of Dr. Werner Von Braun to the moon, and on to the vastness of space aboard the International Space Station. Although America has recently suffered a tremendous loss with the *Columbia* shuttle accident, we certainly will not stop our pursuit of space exploration.

NASA has, from its inception, been charged with making the impossible possible. From the early days of the Mercury Program, through the advancements in Gemini, and the triumphant successes of Apollo, NASA has given us a sense of national pride. Yet we must not let our pride fool us into thinking that NASA's work is commonplace. Each time a shuttle launches and a mission is accomplished, it is a miraculous, humbling event.

Space exploration is risky and there will certainly always be risk involved. But as President Kennedy so accurately said in 1962, "We choose to go to the moon...and do the other things, not because they are easy, but because they are hard..."

In fact, American society itself is built upon the idea that success only comes from a stern effort. Our nation came into being as part of this understanding, that liberty had to be fought for. American independence was not given, but earned.

The importance of persistence throughout history seems almost too obvious to clarify. We universally celebrate our heroes who drive past obstacles and hardships. But it seems as if we often take them for granted. When faced with current challenges, such as the loss of the Space Shuttle *Columbia*, many are quick to hesitate and mellow. They assume that success is born easily; that setbacks are failures in principle rather than unfortunate steps in practice along the way.

America is strong. She is steadfast. And she is brave. We cannot let tragedy block our path to the goal. We must not back down.

As Chairman of the Science, Technology, and Space Subcommittee in the Senate, I plan to take an active role in ensuring the dreams of these seven astronauts are not forgotten. As NASA determines what went so terribly wrong, we will be diligent in doing everything we can in the Congress to give NASA the support it needs to make sure we press forward with scientific advances, and that nothing like this happens again.

Our next step will be to determine what the future of space exploration holds for Americans— what our goal is and how we get there. The loss of the *Columbia* should serve as a step in our quest to advance American exploration. It should not hinder or challenge the objective, but make us steadfast in our resolve. The tragedy that NASA is enduring will not dissuade or discourage America from venturing into space. Our commitment to space exploration is firm. And our commitment to discovery remains. America will return to the skies and we will do so with pride.

"We choose to go to the moon . . . and do the other things, not because they are easy, but because they are hard..."

President John F. Kennedy, 1962

Sen. Sam Brownback was elected to the Senate in 1996, and serves as Chairman of the Senate Subcommittee on Science, Technology, and Space of the Senate Commerce and Science Committee, and also serves on the Senate Committee on Appropriations, the Committee on Foreign Relations, and the Joint Economic Committee. Mr. Brownback was elected to the House of Representatives in 1994 following a career as a Lawyer, following graduation with a Law Degree from the University of Kansas and a Bachelor of Science degree from Kansas State University. He is married and has five children.

Remembering KC

By Laura S. Woodmansee

When the Space Shuttle Challenger accident happened in 1986, I was one of those teens who got scared away from space for a while. The sadness of the astronaut's family members was too much for me. But, after my shock and sadness dulled, I came to realize that the exploration of space is so important that it's worth the risks these astronauts take.

This time, with *Columbia*, my feelings are even more personal because I met one of the astronauts in person. I had the honor of interviewing Kalpana "KC" Chawla in May of 2002 for my book, *Women Astronauts*. So, I nearly passed out when I turned on the TV the morning of 1 February 2003 to learn that she and her 6 crewmates died onboard the Space Shuttle *Columbia* as it re-entered the atmosphere. It still seems so unreal.

She introduced herself to me as "KC" and was so kind and absolutely brilliant. She talked about the magic of weightlessness and seeing Earth from space. I only met her once, but I genuinely liked her. She was a nice, gifted person with a radiant smile and a charming Indian accent.

Our interview took place on 14 May 2002, just two months before her originally scheduled July launch on STS-107. Less than six weeks after we met, the mission was delayed and eventually set for a January 2003 launch. For KC to take the time to talk with a writer while in critical mission preparations is still amazing to me. She was a great supporter of public outreach and knew that encouraging young people was important. That's one of the reasons she was so excited about the student experiments on the mission. About one Texas A&M experiment, KC told me, "What's incredible to me is how smart the technology behind this experiment is that the students have come up with." The experiment was called STARNAV and was successfully completed before the accident.

Kaplana, "KC" to her friends, was born on 1 July 1961 in Karnal, India, a market town north of Delhi. A naturalized U.S. citizen, KC was the first, and only Indian-born woman astronaut, but she didn't think that made her special in any way. She told me, "I personally try to avoid all the fuss. Perhaps more than anybody else, I feel very strongly that, you know, that we are human beings on this planet. And, I just feel lucky that I got selected for this program. And I just feel lucky to be assigned to my second mission." She was happy to be doing the things that she liked to do. "I absolutely do not focus, or think of the fact that I was the first this, or the first that," said KC. "I think most of the time, it's really the interest that matters – what you want to do, and knowing that, pursuing that, and then staying on track before tiring out." At that point, a huge smile broke out on KC's face.

KC and I talked for over an hour. One story that I especially enjoyed was about her first flight into space onboard STS-87 in November 1996. "On our flight we had a camera which was mounted in the front and it [was] looking at the Flight Engineer and me sitting behind the pilot," KC remembered. "When you look at that video, as soon as we lift off, there is the biggest smile on both me and my Flight Engineer's faces. And it's sort of stuck on our faces for a lot of minutes. I mean, you look at this and it's hard to believe these people are just looking at their systems and books." That joy carried on into the mission.

"Living in space is so effortless." KC remembered feeling, "like Alice in Wonderland. You can float from mid-deck to flight-deck just by pushing against a wall." When she had a free moment, she looked out the window. She described floating in an almost fetal position with her knees tucked close to her chest and her arms wrapped around her legs. "You see this whole Earth floating by below you, and especially if you are there during the day and night cycle, you get to see a magnificent sunrise with all the colors."

KC remembered watching Earth's storms at night, and how the lightning would shimmer through the clouds. She remembered thinking the experience was "purely magical." She described her return to Earth as, "almost like you were coming into another dimension, because you simply could not touch what you had left." She was obviously looking forward to returning to space a second time to again experience weightlessness and the beauty of Earth from space.

She talked about using low Earth orbit space stations as a base to launch into outer space, of using tools in space, remote sensing, and telescopes. But what KC seemed most excited about was going to the Moon and beyond. She spoke of going beyond a simple return to the Moon; she wanted us to build a research station to study its geology and to peer into outer space. "We've been to the Moon on some very successful journeys, but we haven't really gone there in the [way] that we've gone to low Earth orbit." She spoke of using the lunar environment and searching the south polar crater for water that would allow us to live, build, and make rocket fuel.

KC served as Flight Engineer on STS-107. It was her job during launch and re-entry, "to diagnose that

Opposite Page: Kalpana "KC" Chawla working in SPACEHAB aboard STS-107.

NASA

this is the malfunction, this is what we need to do." It's possible that she was the first person onboard *Columbia* to notice problems with the orbiter.

If you were able to ask KC and her crewmates, they'd tell you that human spaceflight is a risk, but that it must continue. That was their dream and I believe it will continue. To stop exploring space now would be to go against all that the crew of the *Columbia* believed in and worked so hard to achieve. Hopefully, the lessons that we will learn from this tragedy will save lives in the future.

The loss of the *Columbia* crew is deeply sad and painful to me. And to lose our very first space shuttle adds to the grief. But, we have to remember that the *Columbia* crew knew the risks of spaceflight. Because the Shuttle is the first vehicle of it's kind, an astronaut's journey into space is always dangerous. Every astronaut knows that there is always the possibility she won't come home.

It brings me a lot of comfort to know that these women and men were doing what they loved to do up until the very moment their lives ended. Many people don't have careers they love and that's another thing that these astronauts should be remembered for. They had a dream and wouldn't give up until they saw it come true.

Helping young people was important to KC. Her advice was to find what you have a talent for, and to do what you enjoy most. "The hardest thing that anyone of us faces is to really know what it is you want to do," KC told me. "A lot of times the grass is greener on the other side, you know? You, yourself have a talent for something incredible, but you do not value it. [You see] something somebody else is doing and it just seems more valuable. So you are willing to give up on a gift that you have already because something else seems more intriguing – for the time being. So, the first thing I think we should make sure is – 'yes – this is what I want to do.'"

KC had similar advice for people who want to become astronauts. "For the astronaut business, you could really be from widely varying backgrounds. You could be an engineer from literally any field, a physicist, chemist, biologist, medical doctor, geologist; I mean it's just an extremely wide field." As to which field to pursue, she repeated her advice to find what you do best. "Know yourself – 'this is the area I want to pursue, but not because I want to be an astronaut. But, because this is what I love doing. And if in doing so I can get to win this lottery, so to speak, then great. If not, then I've picked up something that I still love doing.' I guess after you've figured out how to get there, the final thing is to make sure you have the perseverance to stay on that path."

Those who are selected to become astronauts have a great responsibility. Astronauts are heroes because they risk their lives to gain new knowledge that will help all of us in the future. Bravery means knowing the risks and taking the chance anyway, because you're doing what you believe is worthwhile.

A videotape of the crew just minutes before the problems began shows KC smiling at the camera. That's how I will remember this brilliant astronaut. Being an astronaut was obviously a great honor to her. But most importantly, she loved her job!

I feel honored to have met KC Chawla. This time, the tragic loss of astronauts has not scared me away from space. Knowing that they lived to see their dream come true gives me comfort. Now that I've met some of these extraordinary people, I realize that they know what they're getting into. I now understand why they are willing to risk their lives to bring knowledge to us here on Earth. We will always honor them for their bravery and vision. And I will always remember KC and her brilliant smile.

Science Journalist Laura S. Woodmansee works in Southern California. Apogee Books published her first book, *Women Astronauts* in 2002. Her latest book, *Women of Space: Cool Careers on the Final Frontier*, also from Apogee, will be released in late Summer 2003. Woodmansee can be contacted through her website: www.woodmansee.com.

Opposite Page: Kalpana "KC" Chawla and Laurel Clark smile for the camera before a training session in the Space Vehicle Mockup Facility at JSC.

Above Left: Kalpana Chawla pictured on Columbia's flight deck.

Above: Portrait of mission specialist Kalpana Chawla

Photos: NASA

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The day
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What do

Alabama

"To be honest, I never gave the space shuttle missions much thought. It's so much a part of what we do all the time in our space program. Now it makes me stop and think just how serious it is. Lives are actually at stake."—Bill S.

By Tammy Ruggles ▪ Photographs by Joe Marino

BRUARY 2003

merica Speaks

the space shuttle *Columbia* fell to earth.
the world mourned. The day America's heart was broken.
edy has touched us all, from space centers, to small diners, to kitchen counters.
es the loss mean to us? What does America's heartland have to say?

Alaska
"You hear things about disasters like the *Challenger*, and you think, surely that won't happen again. Then *Columbia* happens. We just take safety for granted." —Bonnie T.

Arizona
"It feels like when you hear about soldiers dying for our country. Or firemen and policemen dying in the line of duty. This is a lot like that. The crew was so brave. My thoughts and prayers are with their families." —Sandra B.

Arkansas
"Your first response is you want to blame someone. NASA. The control people. God. And then you think, 'These things are bound to happen sooner or later. Human people make human mistakes'. We're just lucky we haven't had more." —Lucas M.

California
"Words can't describe it. I felt like I did on 9-11. That helpless feeling of loss and hopelessness" —Juanita M.

Colorado
"I was deeply saddened by the tragedy, but then a few days later I felt a sense of pride in the crew. They knew what they were getting into. They knew the risks. And they went anyway. They did it for mankind. We have to be proud about that."—Larry S.

Connecticut
"I wouldn't do what they did. It takes a special person to get on a space shuttle and thinking in the back of your mind, 'Something terrible could happen and I may never come home'"—L.M.

Delaware
"You couldn't pay me a million dollars to do what they do." —Jerry R.

Florida
"We grieved as individuals, and then we all grieved together as a nation." —Shelley B.

Georgia
"Sometimes I wonder if it's worth it. When I think of the families left behind, I don't think so."—Charles H.

Hawaii
"We pay millions of dollars to support the space program. We don't expect tragedies like this to happen. But on the other hand, can we really expect them not to?"
—Maria F.

Idaho
"I wouldn't want to be those families right now. No matter how prepared they were for the worst, you know damn well they weren't ready for the news they got."
—H.B.

Illinois
"I'm an emergency relief worker and see death and loss all the time. Still, tears came to my eyes when I heard the news."
—Laura E.

Indiana
"I didn't even know there was a mission until I heard about the disaster."
—Pablo M.

Iowa
"It makes you stop and think about how fragile life is, and how it can be gone in an instant."
—Leah D.

Kansas
"I wanted to write a letter to the family members who lost someone, but when I sat down to do it, no words would come."—Misty S.

Kentucky
"I think the media was insensitive to the families of the *Columbia* crew in the graphic reporting of finding their remains. They could have used more thoughtful terminology in their descriptions."
—Penny L.

Louisiana
"I can think of better ways to spend our tax dollars. Especially when you think about those kids who don't have a parent anymore."—Billy T.

Maine
"I went to church the next day and cried like a baby. And I got angry at God and asked, 'Why, why, why?'"—Sam L.

Maryland
"I didn't know my five year-old-daughter realized the enormity of what happened until I saw her crayon drawings of a broken space ship falling from the sky, followed by a trail of smoke."
—Becky V.

Massachusetts
"I'm just glad it wasn't any of my family on that spaceship."
—Lucas B.

Michigan
"Not many talked about it in my neighborhood. Just goes to show you how we take life for granted."
—Dale H.

Minnesota
"A lot of people serve humanity in different ways. This was theirs."—Melissa H.

Mississippi
"You want to just pull your hair out and scream, 'It's not fair! They were innocent!'"
—Honor P.

Missouri
"I would be looking for somebody to sue."
—Mitch F

Montana
"Space travel isn't like getting in your SUV and driving down to the 7-11. It's serious business, and our country needs to wake up and pay more attention and respect to those brave enough and skilled enough to do it."
—Gerardo P.

Nebraska
"If these were criminals deserving of some extreme form of punishment, it wouldn't be so bad. But these were seven decent people doing a very dangerous job in the name of progress and exploration. At times I think, 'What a brave team.' Other times I think, 'What a waste'."
—Chuck W.

Nevada
"Our society is so celebrity-driven. We idolize drugged-out rock stars and decadent movie stars. We salivate over the dirty laundry of has-been stars. Why isn't more media attention given to everyday heroes like these astronauts? Our priorities are in the wrong place. It's sad that it takes a tragedy like this for the event to get this level of air time."
—F.B.

New Hampshire
"I didn't think much of the space flight until I heard about the disaster on the news."—Steve M.

New Jersey
"Just when our nation starts to recover from 9-11, this."—Luke B.

New Mexico
"I wouldn't want to go up there in space myself, but I'm glad somebody does it. We need to keep reaching out and learning. Even if we lose people in the process. It's our way."—Martina S.

New York
"It was a mini 9-11. They weren't attacked, of course. But they were still taken away from us in a senseless tragedy."
—Luigi M.

STS-107: The Crew

Heroes All

Seven astronauts were lost February 1st when Columbia was destroyed in the skies high above Texas. Twelve children lost parents; four wives lost husbands, and two husbands lost wives. This crew of explorers and experimenters were as diverse a group ever to launch aboard a Space Shuttle. They were real people, risking their lives for all of humanity, journeying into the unmapped darkness to advance the cause of space exploration for ourselves and future generations.

Willie McCool, Pilot

A native of San Diego, California, McCool was a Navy test pilot following his graduation from Coronado High School in Lubbock, Texas. He also was a graduate of the U.S. Naval Academy in Annapolis, Maryland. McCool had flown more than 2,800 hours aboard Navy fighters before becoming a NASA astronaut in 1996. His launch aboard Columbia on January 16, 2003 was his first space flight. He was married with three children.

Lt. Col. Michael Anderson, Payload Commander

Col. Anderson was born in Plattsburgh, New York. His interest in space and flying led him to major in Astronomy and Physics at the University of Washington, where he earned a Bachelor of Science degree. After graduation, Anderson joined the U.S. Air Force as a fighter pilot. He obtained a Master's Degree in Physics from Creighton University, Omaha Nebraska. NASA chose him for the astronaut corps in 1994, and his first flight into space was aboard the Shuttle Endeavour in 1998. He was married with two children.

Capt. David Brown, Mission Specialist 1

Capt. Brown was a native of Arlington, Virginia and was a graduate of the College of William and Mary, where he majored in Medicine and Biology. He attended the Eastern Virginia Medical School where he became a Doctor. He joined the U.S. Navy as a Flight Surgeon but he also became intrigued with airplanes and flying. In 1988 he became one of the few Navy doctors to be accepted into flight training. But his dream was to fly in space, and NASA chose him for the astronaut corps in 1996.

Dr. Laurel Clark, Mission Specialist 2

Laurel Clark was born in Iowa, and graduated from the University of Wisconsin with a medical degree. She joined the U.S. Navy, and became a Flight Surgeon, where she spent a decade aboard ships and submarines and learned scuba diving. Chosen as a NASA astronaut in 1996, her Columbia flight was her first space mission. Dr. Clark and her husband an eight year old son.

ALL PORTRAITS NASA

Rick Husband, Mission Commander

His lifelong dream of being an astronaut was achieved in 1999 when he flew into space for the first time aboard Shuttle Discovery. A native of Amarillo, Texas, Rick was an Air Force Colonel and graduate of Texas Tech University. He was an Air Force Test Pilot, receiving his flight training in Oklahoma before obtaining a Master's Degree in 1990 and entered astronaut training in 1994. He had compiled 3,800 hours of flying time aboard 40 types of planes. Rick was married and had a daughter and son.

Dr. Kalpana Chawla, Mission Specialist 2

Dr. Chawla was a native of Karna, India when she decided to study aerospace engineering. Following her graduation from the Punjab Engineering College in 1982, she moved to America, where she attended the University of Texas, graduating with a Master's Degree in Aerospace Engineering, and then Doctorate from the University of Colorado. She became an astronaut in 1994, and made her first flight aboard the Shuttle Columbia in 1997. Dr. Chawla and her husband lived near the Johnson Space Center in Houston, Texas.

Col. Ilan Ramon, Payload Specialist 1

Col. Ramon was the son of a Holocaust survivor and a native of Israel. He grew up outside Tel Aviv, graduating from the Israeli Air Force Flight School. A veteran of the 1973 Yom Kippur war, Col. Ramon left the Air Force in 1983 to earn a Electrical and Computer Engineering degree from Tel Aviv University. He returned to the Air Force and was selected as a NASA astronaut Payload Specialist in 1997. His Columbia flight was his first. Col. Ramon was married with four children.

1 February 2003

America Speaks

North Carolina

"We didn't need another loss like that. You hope for even one survivor. But there was no one left."—Carrie T.

North Dakota

"I hate what happened, but I don't think we should stop the space program or anything."—Louis P.

Ohio

"The *Columbia* crew sacrificed their lives for space exploration. They are the Christopher Columbuses of our day. We shouldn't see this as just another space craft accident, but a loss for our country, and even the world."
—Tom R.

Oklahoma

"I don't know how much say so we have in whether to keep or ditch the shuttle missions, but we need to be spending the money here on earth."—Mark B.

Oregon

"We lost those astronauts, yes. But we have to forge ahead. Just like they did when the wagon trains came across. We have to grieve, accept, and move on."—Bob D.

Pennsylvania

"Like everybody else, I was glued to the TV when I heard about it. I was rooting for somebody to live. The 9 miners had been saved. So we were hoping and praying that someone would make it. But the news just got worse and worse, and hope got weaker and weaker. Finally we had to realize that there isn't a miracle around every corner. Not for everyone."
—Laura M.

Rhode Island

"It's not the monetary cost I mind so much when it comes to the space shuttle missions. It's the cost of life. It's so high. With our vast technology, can't we use computers to explore, or robots? Do we have to send real humans up there?"
—Sandra B.

South Carolina

"I don't know much about it, but I know how I'd feel if I lost a family member like that."—Sara F.

1 February 2003

America Speaks

South Dakota

"I don't speak for everyone, but sometimes I wonder if these civilians-turned-astronauts know what they're getting into. I guess they know it's more than a ride at Disneyland, and I'm sure they get training and preparation, but still, I would think twice."—Ted M.

Tennessee

"It was a sad day for everybody. One I'll never forget because me and the kids were just talking about it. One of them had to do a book report on space missions. It was awful."—Betty C.

Texas

"Where would we be if explorers turned around and went home halfway across the Atlantic? Do we stop looking for cures for diseases? Do we stop experimenting or exploring? We'd die if we did that. And we'll die, in our spirits, if we ever stop going into space."
—Mike N.

Utah

"It's the worst thing you can hear. I felt helpless. All I could do was pray for those people."—Maria V.

Vermont

"I tried to explain it to my Sunday School class the next day. It was hard. Because the kids kept asking, 'How could God let that happen?' It wasn't an easy day. I can only imagine how it was for the families of the lost crew."
—Mildred M.

Virginia

"The Columbia crew—all the crews—are like our own. People to be proud of. People to look up to. When you lose people like that, a little humanity is lost. And in that loss, won back again."
—Lillian P.

Washington

"Nobody deserves to go that way. It's a tragedy all the way around. That should be a message to appreciate your loved ones, because no matter how careful they are, bad things happen."—Joe K.

West Virginia

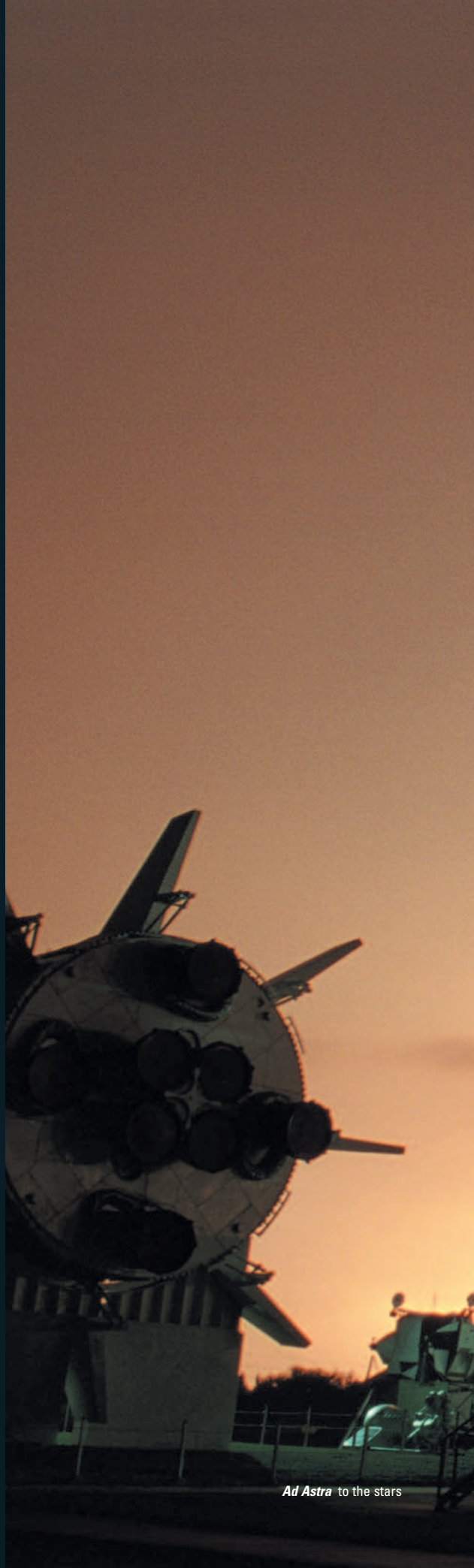
"It reminds me of a flood I was in one time. My house got washed away. I lost some people. You feel real, real small in a time like that. Like a grain of sand in the whole wide world."
—B.E.

Wisconsin

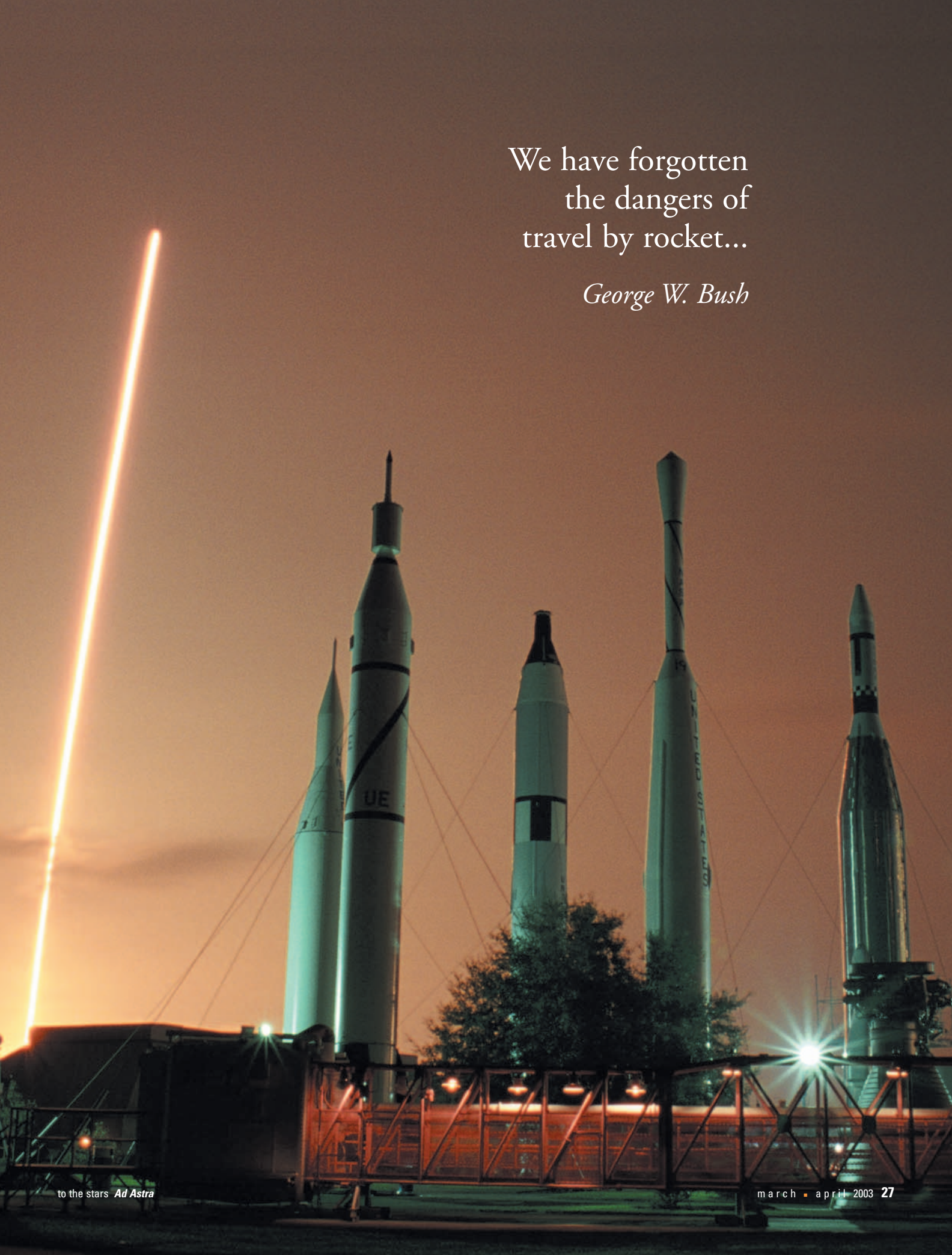
"I'm a veteran, and I've fought in war, and lost buddies in war, and had to fight and kill in battle. I'm a pretty tough cookie and it takes a lot to make me cry. But the astronauts going the way they did, it got to me. They were doing something that I guess about every man, woman, and child dreams about, and that's going into space. It was supposed to be a positive thing. Something good. But it's gonna take a while to find the good in losing them."—C.R.

Wyoming

"If the *Columbia* crew could talk to us right now, they'd say, 'Don't give up. Keep exploring. Keep going up. Do it for us. Do it for everyone'."
—Pete L.



Ad Astra to the stars


We have forgotten
the dangers of
travel by rocket...
George W. Bush


NASA
United States

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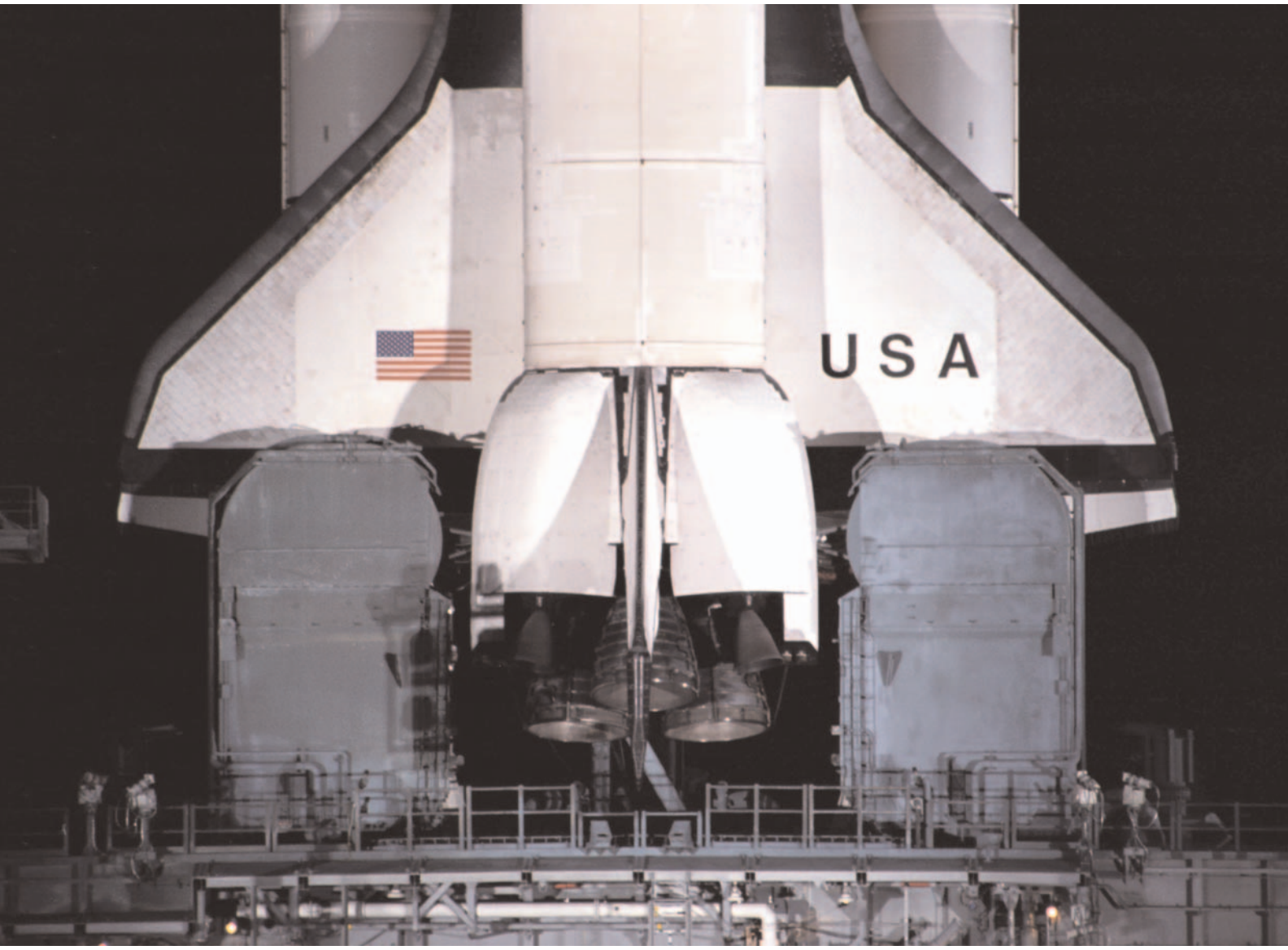
The Role of the



A SPACE SHUTTLE RETROSPECTIVE

By Joan Johnson-Freese

Space Shuttle in Human Spaceflight

In 1986, space historian and policy analyst John Logsdon wrote: In the aftermath of the January 1986 Challenger accident . . . The shuttle is likely to be used only for those missions for which it is particularly qualified, and any notion that it can ever be operated routinely or cheaply has been abandoned. Thus, while the space shuttle is an impressive technological achievement and gives the United States capabilities for manned operations in space that no other country possesses, the shuttle program must be assessed as a policy failure, at least in terms of meeting the objectives that have been its articulated rationale since 1972.

JOE MARINO

NASA

President Richard M. Nixon and Dr. James C. Fletcher, NASA Administrator, discussed the proposed Space Shuttle vehicle in San Clemente, California, on January 5, 1972. The President announced that day that the United States should proceed at once with the development of an entirely new type of space transportation system designed to help transform the space frontier into familiar territory.

In February 2001, the space shuttle Atlantis delivered the $1.4 billion Destiny laboratory to the International Space Station (ISS). Between President Nixon's 1972 announcement that a Space Transportation System (STS) would be built, to its first launch in 1981, the 1986 Challenger tragedy, the first hook-up with the Russian Mir space station in 1995, carrying John Glenn into space in 1998, and delivering the most expensive module to the ISS in 2001, speculations have oscillated considerably about the place that the shuttle would ultimately hold in history.

That the shuttle did not fulfill its original goals was clear in the mid-1980s. But, fifteen years later, it is just as clear that the shuttle has maintained an important role in the space program. That is, quite simply, helping to keep the dream of human spaceflight alive. The space shuttle has kept Americans (and others) in space while attentions on Earth have turned considerably from exploration and imagination to introspection and pragmatism. The so-called romantic era in space — characterized by some as barnstorming and by others as mankind gloriously fulfilling its destiny — may well be over. But the space shuttle has provided an important bridge into the still evolving next era.

Development

In terms of meeting its original goals the shuttle was, from even before its first lift off, the ultimate

NASA

Full view of Space Shuttle Challenger in space. A heavily cloud-covered portion of the earth forms the backdrop for this scene.

mousetrap-designed-by-a-committee and subsequently doomed to policy failure. Looking back to the shuttle's origins as part of the post-Apollo program (PAP), NASA's plan was to utilize the shuttle to take astronauts to a space station, which in turn would serve as a stepping stone to Mars. In keeping with the American been-there-done-that attitude, however, the public and politicians had for the most part lost interest in space after the first Apollo landings. Anyone over 45 who has watched Tom Hanks in Apollo 13 likely squirmed uncomfortably in their chair at the part where the live television broadcast from space is, unbeknownst to the astronauts, canceled due to lack of interest. Sad, but embarrassing — and true. Unfortunately, NASA didn't seem to appreciate the changing mood in the country. Further, its unique and artificial birthing as a fair-haired child among political bureaucracies left them ill-equipped to make their case for a new raison d'être. With all other parts of the PAP canceled or on indefinite hold, NASA was left grateful for the shuttle as a project big enough at least to keep their engineers busy. With no space station, however, the shuttle was from the start a vehicle with nowhere to go.

Hence the scramble began for policy goals, which would theoretically drive development design. There were important intercultural disconnects which occurred early on as well. Engineers design according to mission requirements. Also, NASA engineers had a history of designing spacecraft in the same manner as (Cold War era) weapons systems engineers — and cost was no object. However, in the case of STS, politicians were intimately involved in not only the decision but the design, and cost was most definitely a consideration. Development of a system which would provide low-cost (between $8-10 million per launch), routine access to space (between 25-30 flights per year), and meeting Department of Defense (DOD) requirements for certain space missions were the initial policy targets. Meeting the first goal became impossible, though, due to design changes required to meet the second requirement.

Later, other factors came into play. I was once severely chastised as un-American by an audience member at a military institution when I commented in a lecture that jobs in various federal programs in states critical to Nixon's reelection was a factor in the shuttle approval process. But, from Apollo to the ISS, jobs have always been key to space-policy decision-making. Nixon was also interested in maintaining a potent manned space program — for both the prestige to be yielded and the technology to be developed. None of this is nefarious; it simply made designing the vehicle difficult by engineering standards, especially since there was a budget ax over NASA's neck pretty consistently through the process. Design teams were forced to sacrifice lower operational costs in order to work within the development funds allotted. With a constantly moving target of policy goals, and accountants helpfully sketching shuttle designs for stunned but accepting NASA engineers, its a wonder the shuttle ever flew at all.

Pre-Challenger

But the shuttle does fly, and prior to the Challenger accident, it flew with promises and timetables and cost estimates which, in retrospect, program intimates likely forced themselves to accept, though likely even then didn't believe. Although cost estimates for shuttle missions had grown steadily since the early 1970s, the same type of reassessments were not true of launch schedules. As late as 1984, NASA officials continued to profess the intent of reaching 24 flights per year. There was a continual push for more launches, and a tighter schedule, even though between 1981-86 there were only a total of 25 shuttle missions. As all the reports, studies and investigations have shown retrospectively, the shuttle was an accident waiting to happen in 1986. Far too many of the lessons learned during Apollo were scrapped in the STS program because of fiscal and, yes, political and public pressures, to perform, and often.

After the excitement and kudos which followed the initial flights of the STS, NASA was confronted with a public relations dilemma. It had sold the space shuttle as routine access, but as an agency beholden to federal funds to operate, routine doesn't get the kind of attention that history had shown necessary to sustain a high-tech, high-cost program. Because the shuttle really had nowhere to go, the agency was confronted with the humdrum reality of operating the STS as a local trucking service to orbit. Further, as commercial launches on the Ariane would later indicate, it wasn't even a very competitively priced trucking service.

In the years before Challenger spaceflight had become routine to the American public. Attendance at shuttle launches had dropped, no longer could school children recite the names of the latest astronaut crew, and the media was neither a cheerleader nor merely indifferent, as it had been (both) in the days of the Apollo program. Instead, it was demanding. Dan Rather's network television

news broadcast the night before the Challenger accident exemplifies the external attitudes NASA knew it faced. Instead of stressing the prior launch postponements as evidencing admirable caution on NASA's part, Rather took a more sarcastic approach. "Yet another costly, red-faces-all-around space-shuttle-launch delay. This time a bad bolt on a hatch and a bad-weather bolt from the blue are being blamed. What's more, a rescheduled launch for tomorrow doesn't look good either. Bruce Hall has the latest on today's high-tech low comedy." Yet the media, the public, and politicians seemed almost betrayed when Challenger investigations "revealed" that space travel is very difficult, costly, and dangerous. NASA was damned for changing and in some cases reversing their own standards (contractors having to prove a vehicle safe to fly versus that it was not safe to fly) as part of an effort to maintain their schedule and keep up the pretense of routine access, while attempting to provide space spectaculars on a regular basis.

Post-Challenger

When the space shuttle returned to orbit in 1988, it was with multiple redesigned systems, and a new mandate. No longer would it be used to place commercial satellites in orbit, but it would, as Dr. Logsdon stated, be used for missions specifically requiring its unique capabilities. That was good news and bad news for NASA. Illusions of low-cost, routine access to space were dispelled and they were no longer placed in the impossible situation of maintaining the pretense. What, however, were they to do? What were these missions specifically requiring the shuttle's unique (technical and non-technical) capabilities? Clearly there were some. The Hubble repair mission in 1995 required astronauts. Retrieving the Space Flyer Unit (SFU) in 1996 required the space shuttle's robotic arm. But it was through political maneuvering — United States and Russia merging their manned space programs in 1993 — that the shuttle program really got back on track in terms of having a raison d'être. It was through that political move, vigorously supported by President Clinton, that NASA was able to transform its faltering space station Freedom into the current ISS. Poof! The space shuttle was returned to its original mission from the post-Apollo program! The shuttle would take astronauts to and from the ISS for assembly and, later, crew transport.

In 1995, there was considerable hoopla when the shuttle met Mir in the first US–Russian encounter in space since 1976. The media was on it. The space program was once again receiving considerable attention, and all positive. For some analysts, like myself, however, it was somewhat difficult to buy into the hoopla. In my own case, it was particularly difficult because my space-smart, then-11-year-old-son kept asking why there was such excitement over repeating an event first done almost twenty years prior, and shouldn't we be more concerned that we no longer had the capability to get to the Moon, which we had then. True, true, I mumbled, but this time it was important because it was a step forward toward a space station. The fact that Mir was a space station was not lost on my son, but I managed to evade that issue. It didn't matter, I explained; blasé and cynical attitudes about space had been replaced by excitement and optimism.

Between then and now, another major event in the life of the space shuttle occurred. NASA flew Senator John Glenn on the shuttle in 1998. Politicians had flown on the shuttle before. Utah Senator Jake Garn flew in 1985, and Florida Congressman Bill Nelson flew in 1988. Although the scientific value of their part in the missions can be debated, the political value is indisputable. Both men held congressional positions key to the space program and though supporters before their flights, they became personal champions afterward.

On 30 January 1986, Senator John Glenn was quoted in the Washington Post as saying, "If the taxpayers believe that the space program is becoming a cosmic carnival ride, then we face the very real prospect that they may withdraw their public support." Twelve years later, Glenn eagerly climbed aboard the cosmic carnival ride, just before retiring from the US Senate. The opportunity was clearly too much to pass up — as it likely would have been for most anyone. Since he was retiring, though, his political value as a space supporter in Congress was limited. Why then he got such a valuable ticket on the ultimate congressional junket is uncertain: rumors range from a loyalty reward for his role in the Senate hearings on campaign finance reform to Marine connections in NASA.

The official NASA line was that Glenn went into space at age 77 to study physiognomic effects of space travel on aging. A data point of one, however, coupled with the fact that NASA had just retired their oldest astronaut, Storey Musgrave, at age 62 after being told he was too old to return to space (or maybe he just wasn't old enough) makes the scientific value or priority of the mission questionable. What is unquestionable, however, is the value of returning a certified American hero to orbit. The

NASA

Official portrait of the STS 51-L crewmembers. In the back row (l.-r.) Mission specialist Ellison S. Onizuka, Teacher in Space Participant Sharon Christa McAuliffe, Payload Specialist Greg Jarvis and Mission specialist Judy Resnik. In the front row (l.-r.) Pilot Mike Smith, Commander Dick Scobee, and Mission specialist Ron McNair.

NASA

Endeavour and its crew of six glide in to Runway 15 at KSC's Shuttle Landing in 1996.

positive media attention NASA received was comparable to that in the heady days of Apollo. Senator Glenn chatted with late-night television host Jay Leno from space. Crowds cheered and followed the mission with rapt attention. It went beyond NASA's wildest dreams. And what that reminds us is this: People don't throw parades for robots. Perhaps the romantic era of human spaceflight is gone — but some variation will certainly follow.

The Shuttle Legacy

Exploring for the sake of exploring is clearly not in vogue right now. But that doesn't mean that space travel won't occur in some other form. 1998 was the first year that commercial space spending exceeded that of government space spending. Global space commerce is estimated at over $100 billion per year, and increasing at about 9% annually. The importance of these numbers and their impact should not be underestimated. The tide is turning.

"Space" has long been a development anomaly. Comparing any new field of technology development (computers) or the "opening" of a geographic region (the American West) to space, one finds significant differences. Usually, government plays a key role in providing funding for the initial technology push, or in providing protection for private entities making their move into a new frontier. But when one reviews space history, the government not only provided the funding for the initial technology push, but became the operator for the technology developed. In space, the government not only laid the tracks for the railroads to go West, but through circumstances and sometimes intent, became the train operator and the only passenger.

It took a long time for that paradigm to be broken. In the 1980s NASA Administrator James Beggs had what some considered as the audacity to suggest privatizing the shuttle. He was promptly told by Congress that such an act would be similar to selling the Statue of Liberty — both being symbols of national pride. But the shuttle is not just a symbol, it is a space transportation vehicle. As merely a symbol, it becomes almost untenably expensive to support. Then, when United Space Alliance took over shuttle operations in 1996, Congress hailed it as a transition long overdue. The shuttle continually suffered from being redefined by fungible political goals. That it has withstood its technical and political redefinition is a testament to both the vehicle and the men and women behind it. It has kept Americans in space, in a partially reusable vehicle rather than one originally designed as an intercontinental ballistic missile (ICBM), until this new era of space can define itself.

The transition to the next era will not be easy. Space transportation still looms as the single biggest inhibitor of space development, with the cavalry that was supposed to arrive in the form of a second-generation reusable launch vehicle, unfortunately, not at all a sure thing. The X-33 and VentureStar programs have proved frustrating. The Space Launch Initiative is the newest government plan. Even with technical promise, the same pitfalls which befell past government programs remain. Any program reliant on government funds and direction exists on whim and unpredictability. And, unfortunately, there are still disturbing references to designs for "shuttle derived vehicles." The shuttle has done its job — terminal nostalgia for it will only result in the same ill effects that terminal nostalgia for the Apollo program nearly had for NASA.

There is, however, hope. There are growing and persistent indications — witness the 1998 commercial space figures — that we are finally moving toward a more mainstream development program for space. This program will be one based on market demand and private enterprise rather than politics and public opinion regarding tax dollar priorities. Programs like the X Prize offer new models of working toward new goals. Dare I suggest that space tourism will provide the impetus? Dennis Tito has certainly shown that there is interest.

Tourism efforts do not need to burst forth immediately, fully developed with hotels-in-space, weekend excursions to the Moon and honeymoon brochures. Orbital and even sub-orbital flights for Earth-gazing and the zero-g experience may well provide the impetus for the private sector to get involved and stay involved over the long-term, or as long as there are paying customers. Will space tourism push the next step forward in space transportation? Maybe, maybe not. But if it does, it will have the space shuttle to thank. It should not be forgotten either that the Challenger crew included a teacher, Christa McAuliffe: another testament to the desire of ordinary people to go into space. The space shuttle, with its problems and politics and tragedies and triumphs, did not allow the dream of human spaceflight to fade into obscurity.

And the loss of Columbia won't stop that dream, either. It will keep the dream alive.

SPACE SHUTTLE PEDIGREE

BY FRANK SIETZEN, JR.

SPACE SHUTTLE

Today there are major changes afoot in the evolution of space transportation. For the transport of humans into space, the venerable space shuttle system faces crucial decisions about how long it will continue to fly—and how much the nation will spend on upgrading its systems. The future of the shuttle will directly impact the development of the next generation of reusable launcher—the Space Launch Initiative's 2nd Generation RLV (SLI). If full funding for the actual construction of the SLI-yielded design isn't forthcoming after 2006, when the design selection is set to be made, each succeeding year of delay will require a continuation of shuttle flights.

With the shuttle fleet now entering its third decade of service, any major extension of the shuttles' service will require significant investments in upgraded systems.

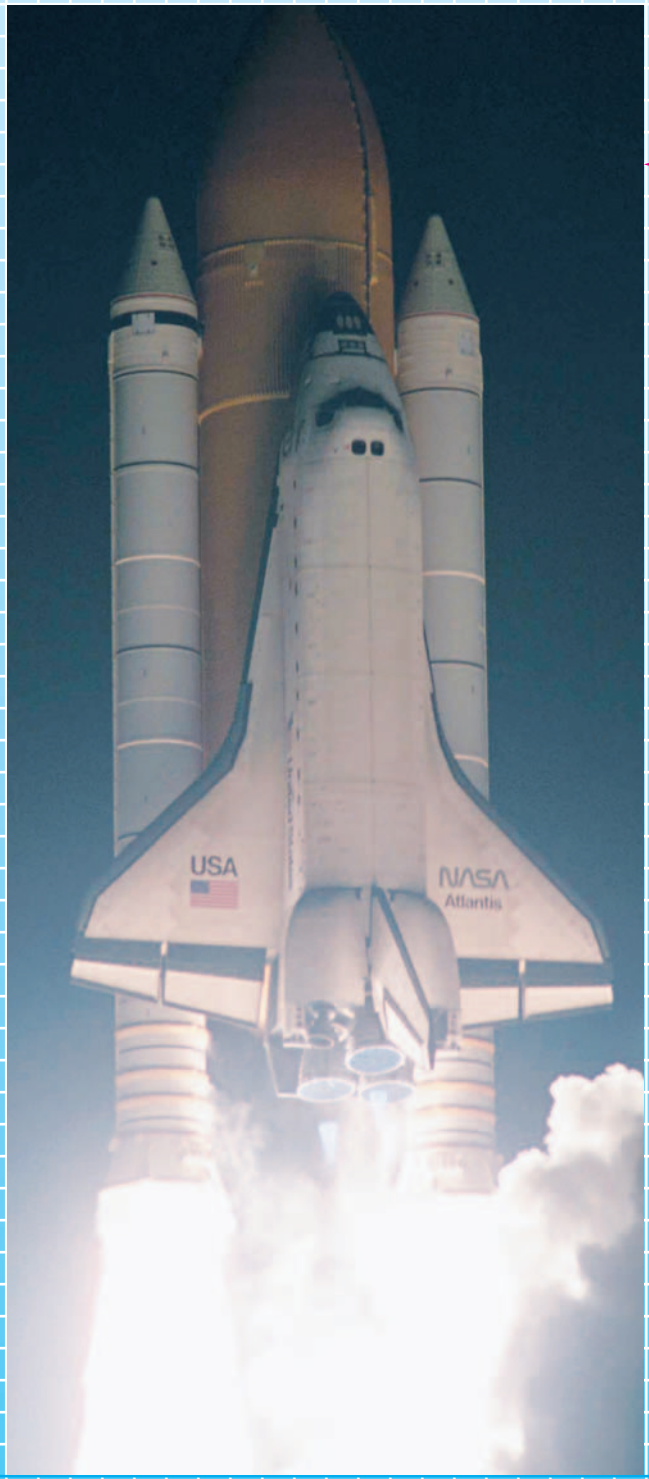
This choice of what kind of space launch system to carry astronauts was faced more than three decades ago, as the post-Apollo NASA faced tighter budgets and an increasingly hostile Congress, all matched by public indifference in supporting expanded space programs following the highly successful moon landings. As NASA planners studied space shuttle designs, a wide variety of flying machines were postulated. NASA officials preferred a fully reusable two-stage winged craft with astronauts aboard both the piloted booster and orbiter. The booster, winged like the orbiter, would separate and fly back to a nearby runway while the orbiter climbed towards space. The craft would have been huge, with the booster the size of the Saturn IB rocket, more than 250 feet tall. Budget restrictions doomed the fully reusable concept, and sent space agency planners on a cost-saving effort to arrive at a configuration that would support civil, military, and commercial payloads. Smaller spaceplanes were also studied, as NASA sought to craft both a launch vehicle as well as a spacecraft that could be an orbital home for experiments and researchers. The following chart, based in part by research conducted in NASA's archives as well as work done in 1987, 1988, and 1989 by Ohio State University Prof. John "Joe " Guilmartin, Jr., shows the myriad types of designs studied by NASA and its contractor families before the present-day shuttle system was selected in 1972.

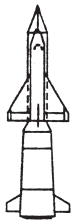
Readers should keep these studies well in mind as the new generation of reusable craft is argued over, debated, and hopefully built. While the technology of today is vastly different than what shuttle planners faced in 1969 through 1972 as they designed the first shuttle, some of the configuration types will look strikingly like those that were studied when the age of reusable spaceflight was young.

For expendable rockets, 2002 marked a new age of lower cost, highly efficient cargo carriers. Last summer, the new Atlas V and Delta IV space boosters made their inaugural launches from Cape Canaveral. Flying from brand-new state-of-the-art launch facilities, these rockets are part of the Air Force's effort to lower the cost of satellite launches while giving U.S. rocket builders a competitive boost. Both the Boeing Delta IV and the Lockheed Martin Atlas V are brand-new, but their heritage lies in ballistic missiles from the 1950s. The Delta IV hails from the Thor Intermediate Range Ballistic Missile (IRBM) as well as Thor-Delta and Delta rockets, and the Atlas V from the Atlas InterContinental Ballistic Missile (ICBM) and commercial Atlas I and II boosters. The Titan line, stretching from the Titan I in the 1950s, through the Gemini-launching Titan II in the 1960s and the Titan IV of the last decade, will end, to be replaced by the Atlas V heavy lift vehicles. Together, these new Deltas and Atlases will carry with them not only the history-making pedigree of the past U.S. rockets, but the future of the U.S. rocket industry in the hotly competitive 21st-century skies.

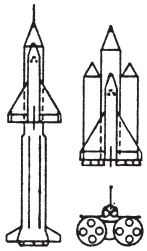
NASA/Eyewire

U.S. SPACE LAUNCH

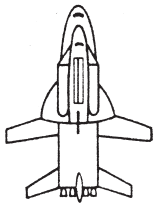




Pump-fed booster

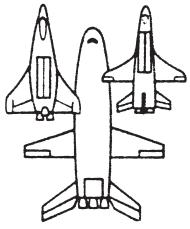


Pressure-fed boosters

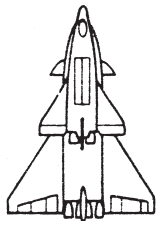


External LH_2 tank Orbiter/Heat sink booster

External LH_2 Orbiter



Common Booster with High (r) and Low (l) range Orbiters



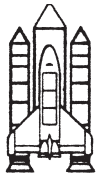
NAR fully reusaable, high crossrange Orbiter

LINEAGE

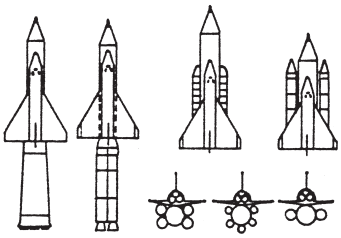
SPACE SHUTTLE

BY FRANK SIETZEN, JR.

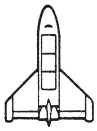
Space Shuttle
(final design)



Space Shuttle

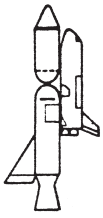


Solid rocket motor boosters



MSC Orbiter 040C
Phase C/D baselines

MSC Orbiter 022B
(first delta wing with
centerline tank)



MSC Orbiter 020A

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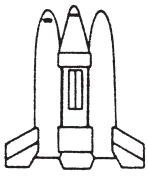
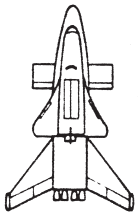
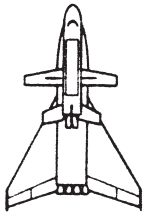


High-Crossrange



MDC fully reusaable, high crossrange Orbiter



Low-Crossrange

THE FUTURE OF SPACE

By Frank Sietzen, Jr.

In the aftermath of the Columbia accident, the future of human spaceflight is uncertain and the present on hold.Until the cause of the STS-107 accident is found, the shuttle fleet is grounded. But this terrible event has highlighted a fact that can no longer be denied: Space transportation is broken.

Everybody agrees that space launch is "broken," in a term used widely today in policy circles within the Air Force and NASA. By broken, analysts mean launching payloads into space—whether it be a human or a satellite—cost too much, takes too long, and often fails spectacularly. The space shuttle fleet, a technologically advanced system when it was designed three decades ago, is today facing aging infrastructure, suppliers that have ceased to exist, and an increasing need for upgrades to keep its missions safe. Expendable rockets like the Titan IV often require months of preparation on the launch pad before making their flights; most remain evolvants of the 1950s era ballistic missiles. What is needed, analysts say, is a fresh infusion of technology and some new wings for these old birds.

TRANSPORTATION

Is it Expendable? Resuables? Or the Shuttle? Why not all three?

And that is exactly what is about to happen, as the future of space transportation is about to move from the debating field to the launching pad. Well, sort of.

Major changes and initiatives are underway that will shape the way the United States launches satellites and people into space in the years ahead. They form the structure of three initiatves—space shuttle sustainment, a new family of cheaper expendable rockets, and a major effort at defining a fully reusable craft to follow the shuttle system.

The Future of the Space Shuttle

Today's space shuttle system—the orbiter, external fuel tank and pair of solid fuel booster rockets—was designed in the early 1970s, and built in the mid-1970s. The launching facilities at NASA's Kennedy Space Center in Florida were modified from those built in the early 1960s for the Apollo-Saturn launch vehicles. Most of these major modifications were completed by the early 1980s—some 20 years ago. Several of the main construction work ended earlier than that. Exposed to the harsh Florida coastal winds, salt air breezes, and rain, all matched by high levels of humidity and heat, the shuttle's launch base is constantly in need of renovations and maintenance. The workforce that sustains these operations is also aging. Estimates made in 2001 suggest that a majority of NASA employees are in middle age, and a large segment will be nearing retirement in the next decade. Hundreds of suppliers for small systems and equipment used on the shuttles and their facilities have either gone out of business entirely or been absorbed by rounds of mergers and acquisitions. Other firms have ceased manufacturing these parts, citing the dwindling level of profitability they entail. These pressures have forced NASA to pay top dollar to keep some of these ancient systems in supplies. In some cases, the agency and its contractors have earlier this year begun surfing Ebay looking for surplus parts for the shuttle fleet!

At issue is how best to maintain space shuttle operations, and how long until a successor reusable system emerges from the drawing boards. In the mid-1990s, NASA and the National Academy of Sciences initiated a review of what systems aboard the shuttle vehicles needed replacement by either more advanced technology, or new equipment that would lower the cost of shuttle flight while increasing safety. The result of this review was a detailed plan, set before Congress in 1999 to spend more than $2 billion over the next decade in upgraded systems. In its original form, these upgrades would replace the orbiter's hydraulic steering system with an all-electric design, new computer technology, less toxic thrusters, and other elements. The idea was to infuse new technology into the shuttles well before their retirement began, then envisioned to start in 2012 and end about 2014 when a new generation of shuttlecraft would be flying.

But NASA's budget has failed to grow over the past decade, while at the same time cost increases in the agency's flagship project, the International Space Station, have ballooned. Until the advent of the Bush administration in 2001, whenever cost increases in other programs have occurred, NASA has raided the budgets of other programs. More than $600 million in shuttle spending has been deferred as a result, with upgrades affected. Some of the original upgrades reported to Congress were canceled, NASA saying that they had veered out of budget alignment or been rendered as not a priority in the new analysis. Most, however, had been deferred due to the cost pressures building in the human spaceflight program. Some of the more ambitious upgrades in the study phase, such as escape systems or new boosters, have been quietly shelved.

But the idea of retiring the shuttle beginning in 2012 has been itself the subject of a review, as the prospect of a second generation shuttle pushed further into the future by a combination of budget issues and technology. In the spring, new NASA administrator Sean O'Keefe ordered a review of the implications of continuing the use of the shuttles for not a decade more, but possibly to 2020—some 18 more years. And some in the space community have suggested that if the development of the new generation craft proves to be too challenging, that date could be extended even more, to 2025 or longer. O'Keefe's study is to assess what would be needed to maintain a reinvigorated shuttle fleet for nearly another quarter century: new systems, but also new upgraded pads, processing systems, and other related facilities. The pricetag won't be cheap—most likely in the billions. But if the new RLV takes longer than

NASA

Left: In this Boeing photo, space shuttle Endeavor is rolled into the Vehicle Assembly Building for attachment to its flight hardware.

anyone expected, the issue will be how to continue to ferry astronauts and large payloads and equipment into space.

Is continued shuttle flight the best way to assure U.S. access to space until RLV II comes on line? Or would a combination of a small spaceplane, lifted into orbit by one of today's new generation of throw-away rockets be a better step?

That future of the shuttle review is to be completed by early next year. Then NASA, and the contractor community that maintains the fleet of shuttles, will face the decision of how best to keep U.S. astronauts flying.

The Space Launch Initiative

Of course, to replace the shuttle would require development of something to replace it. Enter the NASA Space Launch Initiative. A five year, $4.8 billion effort started in 2001, the SLI is intended to arrive at a series of both human-carrying reusable launchers as well as non-people carrying cargo craft by 2006. From more than 100 potential system designs, SLI has downselected to five space industry contractors and 15 potential launchers. In four years, the SLI effort is to recommend to NASA the form and capability of a fully reusable, commercially exploitable family of RLVs, all of whom are to be cheaper and more operable than the shuttle fleet.

So what's the problem with that?

Only many are convinced that SLI will need more than four years to come up with a shuttle replacement. Some are saying that in addition to viewgraphs, SLI should also include prototypes and test vehicles flying out some of the risk in building the new craft. For that there are no funds in the current budget.

And in addition, there is no funding "wedge" currently inserted in the NASA budget planning for 2007-2012 when the actual construction of the SLI-recommended craft would theoretically occur. The cost of the RLV could be in the $16-$20 billion range. In a flat budget environment, NASA would be hard pressed to build this shuttle replacement without a fresh—and major—infusion of cash.

Some members of Congress, like Florida Senator Bill Nelson (D) have suggested that the Pentagon should foot the bill for the technology development program for a new RLV. Recently, the Defense Department started their own SLI-like project aimed at researching military roles for a reusable launcher. Called the National Aerospace Initiative (NAI), this project is aimed at spending $2.6 billion between now and 2008 on designs for something called a Space Maneuver Vehicle, an unpiloted reusable launcher and spacecraft combination. Unlike NASA's SLI, the NAI is to perform a space test flight of a prototype in 2008.

O'Keefe has suggested that SLI and NAI should work together and coordinate the reusable system that emerges from their studies. He has extended a "120 day One Team" joint NASA-USAF study that began to look last year at the common requirements the two agencies had for reusable launch vehicles. But no matter what designs finally emerge as the chosen form, funds will have to be found from either NASA, the USAF, or somewhere else to actually pay to build—and eventually operate—whatever type of reusable system that some day follows the shuttle fleet into space.

Evolved Expendable Launch Vehicle

For the expendable launcher field, the pathway to the future is not so clouded. By the time these words appear in your mailbox, a new generation of throwaway rocket will have taken to the skies above Cape Canaveral, Florida. If all goes well, nearly a decade of planning—and about $3 billion in spending—will have yielded a new family of cargo rockets cheaper and more commercially competitive than any that have flown before. In 1992, the Defense Department, concerned that the cost of space launches of its military satellites was sufficiently high to consume greater and greater parts of the military space budgets, initiated yet another round of studies about U.S. space launch capabilities. This followed three previous launch studies of the late 1980s. The National Launch System, Advanced Launch System, and Spacelifter all looked at new generations of expendable space boosters, but all failed to obtain sufficient support in either the Pentagon or Congress to literally get off the drawing boards and into development.

The 1992 study, headed by Air Force General Thomas Moorman, resulted in a definitive series of recommendations when delivered to Air Force leadership in 1994. The key recommendation was development of a single family of rockets to replace the existing Atlas, Delta, and Titans. New boosters would be fully expendable, and would seek to have limited technology and development goals: reducing the cost of launch by 25 to 50 percent over the existing rocket fleet. These expendables—called Evolved Expendable Launch Vehicles—would begin flying in the early 21st Century, and initiate a gradual phase-out of the precursor boosters.

The pair of EELV families that emerged from the contract competition would be the Boeing Delta IV and the Lockheed Martin Atlas V. The Boeing rockets would feature the first new U.S.-made liquid rocket engine since the development of the shuttle. The Lockheed Atlas would import to the U.S. a variant of the Russian engine that powers that country's Energyia and Zenit booster rockets. Together with state-of-the-art launching pads at Cape Canaveral and Vandenberg, the EELV era would deliver more commercially competitive launchers that would at last challenge the Ariane 5 for world commercial space launch leadership.The EELV program will support not only military and civil government space launches, but the rockets will be available for commercial contracts, lifting communication satellites and other satellite cargoes. While industry details are proprietary, both rocket families are believed to have slashed the cost of launching to record lows—making Atlas V and Delta IV tough new competitors.

The flights of these new craft will infuse new technological blood into the U.S. rocket industry. And if only SLI or NAI will do the same, U.S. access to space will improve as well, blazing a new trail for people and cargoes into the 21st Century skies.

NASA's latest concept is an Orbital Space Plane to fly along with the redesigned shuttle fleet, carrying people and limited cargoes to space while the shuttle lifts heavy equipment. Congress has yet to embrace the OSP, and NASA has yet to design a path from today's post-accident shuttle fleet, to a new environment for both human spaceflight and expendable cargo vehicles. The future is, literally, up in the air.


NASA

Making The Pursuit of Space A Place For All

Minority Graduates and Their Participation In The U.S. Space Program

By Jim Romeo

"Years ago, when the U.S. Space program was getting off the ground, it would have been unlikely that a woman would be leading research for NASA," says Dr. Irma Becerra-Fernandez Director of the Knowledge Management Laboratory and a Professor of Information Technology at the College of Business Administration at Florida International University's in Miami, Florida.

Over the years at NASA, things have changed.

The National Aeronautics and Space administration (NASA) is strongly committed to its goal of broadening the participation of Historically Black Colleges and Universities (HBCU) in the Agency's research programs and missions.

The agency sets its goals to assist this community by setting several objectives:

- Facilitate research and development activities at minority institutions that contribute substantially to NASA's mission.
- Create partnerships and programs at Historically Black Colleges and Universities that enhance research and educational outcomes in NASA-related fields.
- Provide incentives and programs to prepare faculty and students at Historically Black Colleges and Universities to participate in research of NASA.
- Partner with Historically Black Colleges and Universities to increase the number of students who enter college and pursue undergraduate degrees that would benefit NASA efforts.

In 2001 NASA invested nearly $51 million in Historically Black Colleges and Universities in support of the Agency's research and education objectives.

Dr. Fernandez has spearheaded many projects in her Knowledge Management lab. Knowledge Management seeks to harness the greatest value from human intellect. Any information in one place in an organization can be used in

some way somewhere else in the organization. It's a hot information technology for most of industry and it certainly is a hot topic at NASA these days as they fund various research projects related to Knowledge Management to improve their own efficacy.

Dr. Fernandez is just finishing up a $300,000 project called Seeking Experts using a Searchable Answer Generating Environment (SAGE). This collaborative computing project is aimed at developing an "Expert Seeker"—a tool designed to catalog and allow intuitive access to expertise

African-Americans And The Space Program

The civil rights movement that grew out of the early 1960s paralleled the development of the U.S. Space Program. As the civil rights movement made advances, so did the space program.

Today, many members of the African- American community have made significant contributions to the space program. In addition to approximately 14 African-American astronauts, there are numerous scientists, mathematicians, and other professionals who have made significant contributions. Here is a sampling of those African Americans who have contributed:

- Robert Shurney, a physicist from Tennessee State University, designed the tires for the moon buggy used during the Apollo 15 mission in 1972. His ingenious design used wire mesh in the place of rubber to save weight yet still provide the needed flexibility.
- Dr. Vance Marchbanks, a heart surgeon and medical specialist for NASA, helped develop ways to monitor astronauts' vital signs during space flight. It was Dr. Marchbanks who was responsible for John Glenn's health during America's first orbital flight.
- George Carruthers, an astronautical engineer, built the camera that was carried to the moon on Apollo 16. He also designed and built a combination telescope and camera used on the shuttle missions. Some of the most enduring images from space were made using Dr. Carruthers' cameras.
- Christine Darden, a mathematician and mechanical engineer, has been with NASA since 1966. She is a recognized leader in the reduction of shock waves from spacecraft wings and nose cones.
- Patricia Cowings, a psychologist from the University of California, has been conducting NASA space flight research for over 20 years. Dr. Cowings was instrumental in developing ways astronauts could use biofeedback to reduce space sickness and headaches in space.
- Guion Bluford, a former Air Force pilot and first African-American in space, logged 688 hours over four space shuttle missions, beginning with his first flight in 1983.
- Frederick Gregory, another Air Force pilot, and graduate of the Air Force Academy, made his first space flight in 1985. He went on to command Space Shuttle *Discovery* in 1989 and served as mission commander of the Space Shuttle *Atlantis* in 1991.
- Charles Bolden, a graduate of the U.S. Naval Academy and Major General in the Marine Corps, logged two space shuttle missions in 1986 and 1990 before serving as mission commander on *Atlantis* in 1992 and *Discovery* in 1994.
- Mae Jemison was the first African-American woman in space. During an eight-day mission on *Endeavor* in 1992, she conducted space-sickness experiments and conducted research on bone loss in zero gravity. In addition to a B.S. in chemistry and a degree in medicine, Dr. Jemison also holds a degree in African-American studies.
- Dr. Bernard Harris, flight surgeon on the *Columbia* in 1993, was the first African-American to walk in space during his flight on the *Discovery* in 1995. During that same mission, Harris conducted experiments on the Russian MIR spacecraft after a linkup in orbit.
- Ronald McNair, a much-loved physicist from New York, was aboard the 1986 *Challenger* Mission that exploded above Cape Canaveral where he perished.
- Maj. Robert J. Lawrence was killed in a crash during a training mission in 1967. Both he and Ronald McNair were highly respected by their peers and greatly believed in the space program.

Frederick D. Gregory was confirmed by the U.S. Senate as the first NASA Deputy Administrator. Gregory, a veteran Space Shuttle commander who previously served as the Associate Administrator for Space Flight, became the agency's first African-American deputy.

within NASA's Kennedy Space Center. The application is that it will serve as a repository of intellectual capital within the Space Center by identifying and sharing research and researchers for collaboration.

The intent of NASA's involvement with these institutions seems to be putting intellect in the right place. The Hampton University Center for Atmospheric Sciences (CAS) Co-Directors,

At Hampton University, in Hampton, Virginia, in the shadow of NASA's Langley Research Center, Professors M. Patrick McCormick and James M. Russell III play Principal Investigator roles for 6 NASA satellite experiments to study Earth's atmosphere. Both had spent nearly 30 years working for NASA. They've moved just 15 miles down the road to Hampton University and are now involved in these 6 NASA satellite experiments.

Four are in orbit now (SAGE II, HALOE, SABER and SAGE III). Two others are under development (CALIPSO and AIM). Hampton University is the Co-Principal Investigator for CALIPSO. Hampton University has come along way in the role it now plays as a Historically Black College and University for NASA.

"When Professors McCormick and Russell came to Hampton University in 1996, they established Center for Atmospheric Sciences" says Dr. James Russell, Co-Director of the Center for Atmospheric Sciences and Professor of Physics at Hampton University in Hampton, Virginia.

"Before that time, there was little to no involvement of minorities in atmospheric science," adds Dr. Russell. "Now Hampton University has become the first Historically Black Colleges and University in history to have full responsibility for a NASA satellite experiment including the science leadership, the instruments, the spacecraft and the launch vehicle. This is an unparalleled and significant opportunity to get minorities involved in space science in a major way."

The Small Explorer Program

Hampton University is the first historically black college or university ever to be selected to be solely responsible for NASA's Small Explorer (SMEX) Program. The $92-million mission includes hardware, software, flight operations, science team leadership, science data collection, reporting, data archival for use by the scientific community and education and public outreach.

NASA's Small Explorer (SMEX) Program provides frequent flight opportunities for highly focused and relatively inexpensive space science missions. SMEX spacecraft are 180 to 250 kg with orbit-average power consumption of 50 to 200 watts. Each mission is expected to cost approximately $80 to $90 million for design, development and flight operations.

This mission will enhance the research environment at Hampton University and it will also provide the opportunity for significant Hampton University student training in carrying out satellite missions."

Students will assist a team of experts in a variety of efforts including the design and implementation of the science data system, information retrieval from remote sensing instruments, instrument test data evaluation and instrument in-orbit performance trending studies. Students also will assist with the operation of the AIM Project Data Center at Hampton University and with implementing the education and public outreach program.

Other partners with Hampton University on the AIM project are the University of Colorado, which will build two instruments and the spacecraft palette; Utah State University and the Naval Research Laboratory, which each will build an instrument; Ball Aerospace and Technology Corporation, which will build the spacecraft and GATS Inc., which is responsible for software and AIM data management.

AIM is Hampton University's sixth active NASA satellite mission. Current projects are: HALOE, SAGE II and III and SABER all operating in orbit and CALIPSO under development jointly with the NASA Langley Research Center.

The university's commitment to atmospheric sciences and international research programs has been sparked by the $250 Million fundraising Campaign for Hampton, which was increased from its $200 million goal in 2001 and has added new academic endeavors and increased scientific resources.

Russell hopes to bring more and more minorities into NASA research and into the Principles of Physics in general. He cites an American Institute of Physics survey that found that of the 34 historically black colleges that have physics programs, nearly 60 percent of all bachelor's degrees and 38 percent of all master's degrees awarded to African Americans in the discipline come from these colleges and universities.

The same survey showed that just 5 percent of undergraduate degrees awarded in physics in 1997 were earned by black students. From 1973 to 1996 it found, fewer than 200 African Americans had earned doctorates in physics. From 1994 to 1998, Hampton's physics department awarded seven of those Ph.Ds.

During that same period, the department also awarded 20 bachelor's and 10 master's degrees. Although they say they would like to have more black students in the program, the two researchers are pleased with the progress they've made so far. "We're really starting to see the manifestation of what we are trying to put in here," said Mr. McCormick. The center's staff is aggressively recruiting students, and Mr. McCormick and Mr. Russell are trying to make the program accessible to students who are interested in science but aren't fully prepared. "Some of these students, we're going to have to bring in and teach," says Mr. McCormick. He envisions some having to spend as much as a year in remedial classes sharpening their math and science skills to prepare them for physics. For now,

Taking the Fear Out of Math And Science

"Math and Science are my weaknesses."

That is a familiar phrase to NASA's Dr. Sandra Proctor.

Proctor who serves as the special assistant for education at the NASA's Langley Research Center in Hampton, VA, along with a colleague, developed a proposal aimed at making math and science less intimidating to prospective students. It honed in specifically on minority college students with an interest in teaching elementary and secondary school students in science, math and technology.

"We can't let them be science phobic and take that into the classroom," Proctor says of the prospective teachers. "We have to break it down here."

They hold an annual Pre-Service Teacher Conference each year in combination with Norfolk State University of Norfolk, Virginia, that draws some 500 college students from approximately 30 historically black colleges and universities, Hispanic-serving institutions and tribal colleges.

Last year, the students, also referred to as pre-service teachers, chose from 36 hands-on workshops led by area public school teachers, NASA scientists, college faculty and representatives from the technology industry.

The workshops entail hands-on participation by faculty and students to engage in learning the "cool" side of science an math and develop a true interest and curiousity that will hopefully grow into a pursuit of a math and science teaching career.

Using basic materials — balloons, Styrofoam cups, string and a stick — the 30 prospective teachers made rockets, cheering when it was evident their project was successful.

"This is what makes science fun," Proctor says.

Proctor and her colleagues say the two-day conference provides the pre-service teachers with exposure. For many of the students, it is their first experience meeting other students from around the country who have the same interests and career goals.

"It's their first induction into professionalism," says Dr. Leo Edwards, director of the Math/Science Education Center at Fayetteville State University in North Carolina.

Hathaway, university affairs officer at NASA Langley, says the conference also is an opportunity to make students aware of the challenges of teaching, while fostering interaction between faculty and students.

But the conference, the faculty facilitators say, is just a taste of what they really want to offer the students. When Proctor and her colleagues first presented the pre-service teacher conference concept to NASA Headquarters in Washington seven years ago, officials there immediately told her to begin the program and to expand it.

the directors are confident in the program they've built, and see a lot of promise for the future. "When we retire, we want to leave a strong atmospheric-sciences department here," Mr. McCormick says, "putting out Ph.D.s who are marketable anywhere.

Specifically, Russell hopes to take research and development of satellite operations one step further. "One activity that we have been advocating is to establish a mission operations center here at Hampton University where students can take part in operating a real satellite by sending commands, monitoring health and safety of the spacecraft and distributing scientific data to the user community," says Russell. " We have already been working on this with the Laboratory for Atmospheric and Space Physics (LASP) at the University of Colorado in Boulder where we have sent students in the summer to work with LASP and learn how this is done."

The efforts at Hampton University to manufacture the type of graduates that will benefit NASA is in its embryonic stages but they're starting to see some graduates take off. "Our program is very young and as yet we have not graduated students in the atmospheric sciences" adds Russell. " However, three of our students have passed the PhD qualifying exam and a fourth who is a minority student is nearing completion of his work for the MS degree."

According to Dr. Fernandez, minority students who have worked in her Knowledge Management laboratory have transferred this knowledge and skills to other organizations after graduation. "Ever since I founded my research lab in 1997, it has been staffed solely by minorities," says Fernandez. "More than 50 students have already graduated after working in an internship at the Knowledge Management Lab and are consistently recruited by Fortune 100 companies such as: Bellsouth, FPL, KPMG, FedEx, Goldman-Sachs, LHS Group, IBM, GE Medical Systems, Accelerated Ecom, Deloittle-Touche, Lennar and Motorola."

Says Fernandez: "It has been very exciting working for NASA, which I find a very progressive agency, even in the area of promoting women and minorities. I feel NASA employees have an incredible dedication to their mission and to serve."

Jim Romeo is a freelance writer based in Chesapeake, VA. He is the author of Net Know-How. Surviving the Bloodbath. Straight Talk From 25 Internet Entrepreneurs *(2002, Aegis Publishing)*

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The Human Journey

By Brian E. Chase, NSS Executive Director

The world has lost seven heroes, and we mourn together.

Yet the strongest voices supporting the continued exploration of space, even as we are stunned at the tragic loss of *Columbia*, comes from those who assume the risk—the astronauts and their families. The words of President Bush echoed theirs, and the National Space Society supports the President's determination that "our journey into space will go on." NASA and our space exploration initiatives must move forward.

Yet it was also inevitable that those opposed to human space exploration would take full advantage of the loss of the Space Shuttle *Columbia* to ply their trade. The inevitable argument is that robots can explore space, so why do we need humans?

In reality, any balanced space exploration and development program should use both robotic probes and humans, not exclusively one or the other. Indeed, there will be destinations in our universe with environments so hostile or in locations too remote that humans will never be able to visit, so there will always be a critical role for robotic exploration. As well, robotic probes can and should serve as critical pathfinders for future human missions.

But the mobility, dexterity, intellect, reaction time, situational awareness, and observations of human explorers will always surpass the capabilities of robotic or automated probes, even those remotely operated by humans.

If robots are superior to humans, then why do we send research teams to Antarctica? Why do scientists dive in the depths of the ocean? Why do researchers explore the interior of active volcanic formations? Would those same critics opt to replace their presence in an Earth-based laboratory with a robot or automated system?

Brian E. Chase

And why do people choose to travel for a vacation, rather than surfing the internet, watching videos or looking at postcards of that same destination?

Because mankind has a natural curiosity and a need to explore, and there are activities unique to humans that allow us to observe and interact with our surroundings in ways that robots never will. There simply is no substitute for a person "in the loop" whether on Earth, in LEO, or on another planet.

Our exploration of space is just the first step, though. The mark of a truly spacefaring civilization is the day that ordinary citizens can decide whether to live and work on Earth or opt to live away from our planet. We have a long journey to reach that point, but the journey is worth the risk and the expense, and will yield enormous economic, scientific and commercial benefits along the way.

History teaches us that societies that have pushed their frontiers outward have prospered; those that have not have withered and faded into the history books. No society has ever gone wrong opening up the frontier, and we shouldn't stop now. The crews of Apollo 1, *Challenger*, and *Columbia* would expect nothing less.

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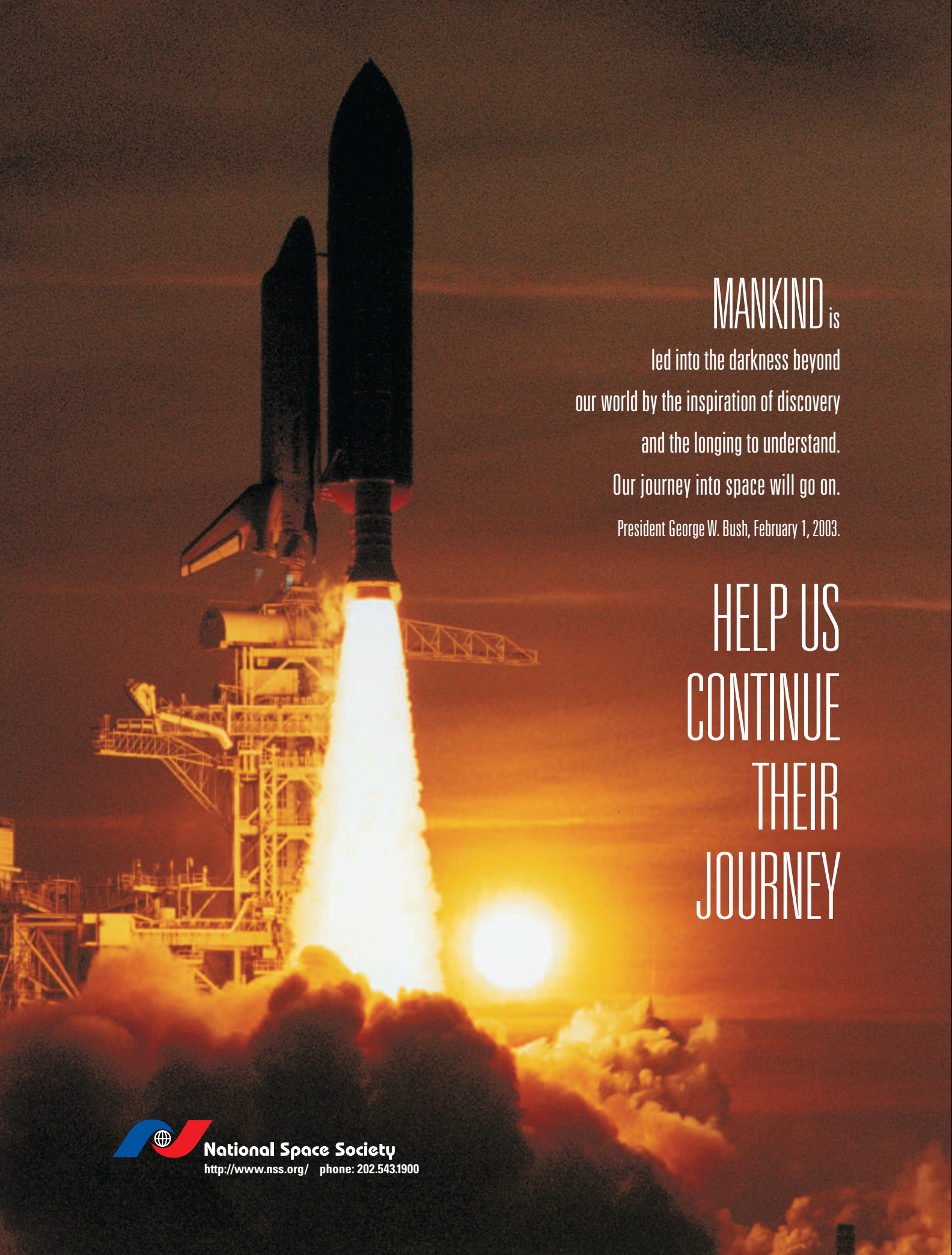
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led into the darkness beyond
our world by the inspiration of discovery
and the longing to understand.
Our journey into space will go on.
President George W. Bush, February 1, 2003.
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