The X-PRESS

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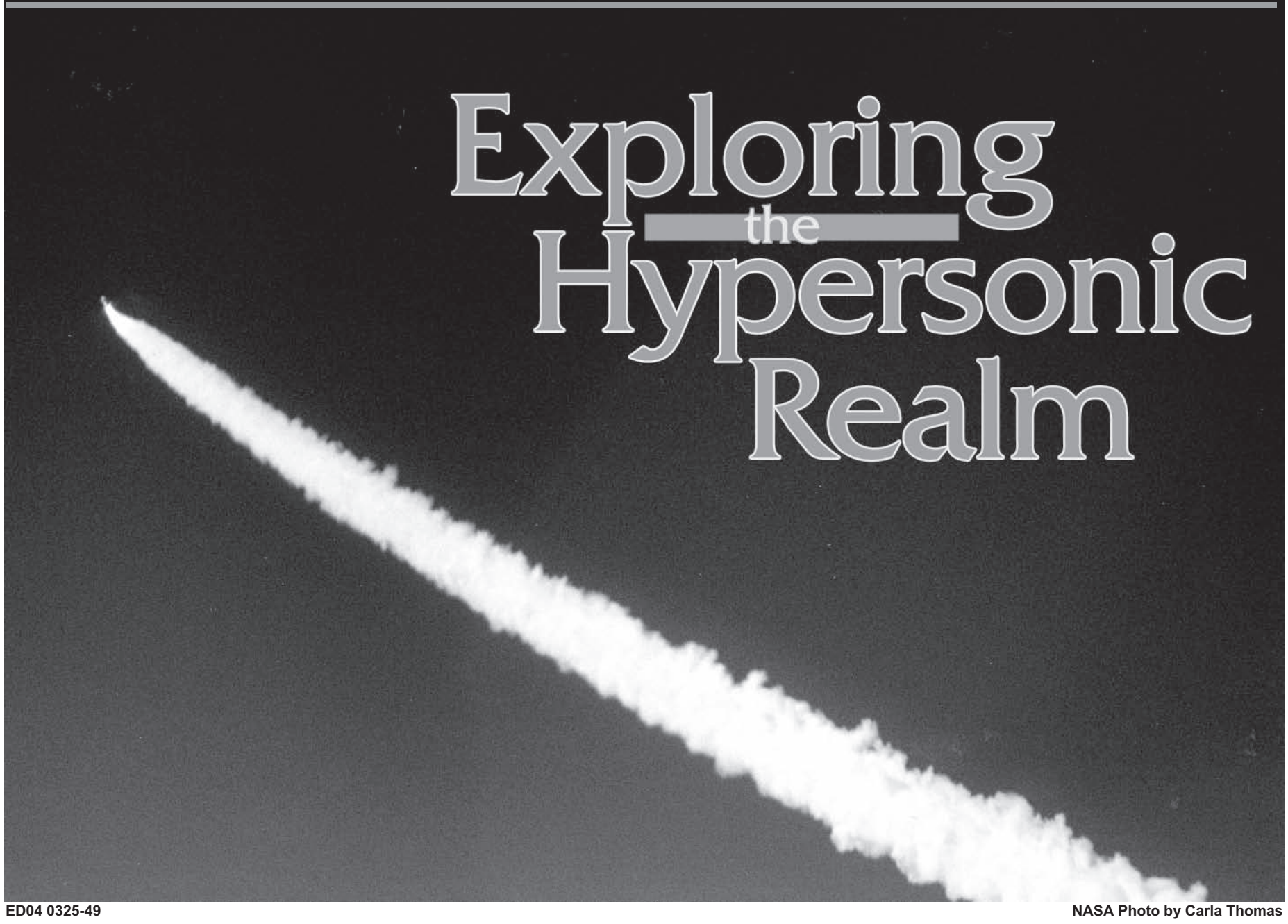
# Exploring the Hypersonic Realm



ED04 0325-49 NASA Photo by Carla Thomas

## ■ Dryden and Langley researchers see Mach 9.6 on record X-43A flight

**By Jay Levine**
X-Press Editor

The X-43A team shattered a speed record Nov. 16 for the second time this year when the aircraft successfully reached speeds approaching Mach 10.

The team celebrated the first flight of an integrated airbreathing supersonic combustion ramjet (scramjet) engine during a March 27 mission in which the X-43A separated from a rocket booster and flew at about 5,000 mph, or Mach 7. Researchers reported that initial data from the Nov. 16 flight shows the scramjet-powered research vehicle successfully flew at an altitude of about 110,000 feet, at speeds of about Mach 9.6, or 6,500 mph.

**More X-43A coverage pages 4-6**

Dryden X-43A project manager Joel Sitz said the X-43A team has completed its job.

"We've given industry and government a lot of confidence to go forward with hypersonic flight and hypersonic airbreathing propulsion. I think that technology definitely has a future, and we definitely opened that door. We completed 100 percent of the goals this program had set out to achieve," he said.

The high-risk, high-payoff flight with the revolutionary engine technology took place in restricted airspace over the Pacific Ocean northwest of Los Angeles. The flight was the final and fastest of three unpiloted flight tests in NASA's Hyper-X program. The program was designed to explore an alternative to rocket power for space access vehicles.

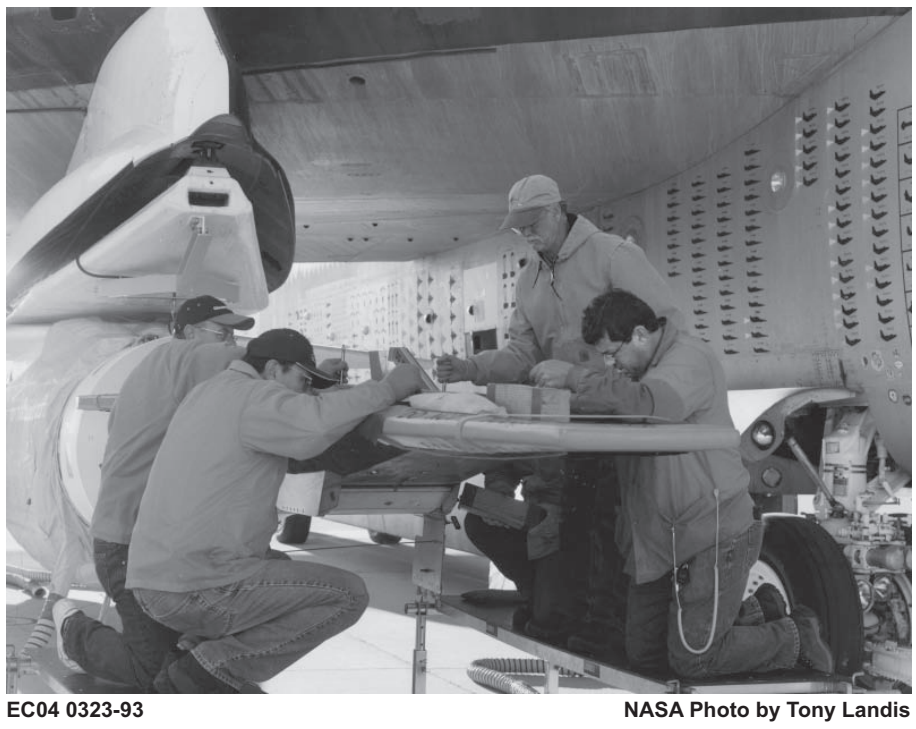
"This flight is a key milestone and a major step toward the future possibilities for producing boosters for sending large and critical payloads into space in a reliable, safe, inexpensive manner," said NASA Administrator Sean O'Keefe. "These developments will also help us advance the vision for space exploration, while helping to advance commercial aviation technology."

NASA's associate administrator for the aeronautics research mission directorate, J. Victor Lebacqz, congratulated the team.

"The work of the Langley-Dryden team and our Vehicle Systems Program has been exceptional," Lebacqz said. "This shows how much we can accomplish when we manage the risk and work together toward a common goal. NASA has made a tremendous contribution to the body of knowledge in aeronautics with the Hyper-X program, as well as making history."

While congratulating the X-43A team on the mission, Lebacqz also explained

**See X-43A, page 8**



EC04 0323-93 NASA Photo by Tony Landis

*From left, Terry Bishop, Dale McKill (ATK-GASL), Joe Kinn and Randy Wagner prepare the X-43A research vehicle for flight.*


ED04 0320-16 NASA Photo by Tom Tschida

*NASA's B-52B takes off from Dryden on its way to air launch of the "stack," comprised of the booster rocket and X-43A testbed.*

# Center Director's Column

## X-43A team expands hypersonic flight envelope

My heartiest congratulations to the X-43A team for a remarkably successful flight on Nov. 16, reaching about Mach 9.6 at about 110,000 feet. As NASA Administrator Sean O'Keefe said, "it will help us advance the vision for space exploration while also helping to further commercial aviation technology." Mr. O'Keefe made a point of calling me shortly after the flight. He watched the flight live on NASA TV and wanted to make sure the entire X-43A team knows how proud he is of the unparalleled accomplishment and the exceptional people who made it happen.

A major key to the success of this remarkable program was teamwork. The Hyper-X program involved cooperation among NASA Headquarters, Langley Research Center, Dryden and our numerous industry partners. The success of this ambitious effort required open communications, a willingness for team members to help one other, an acceptance by all participants of responsibility for the outcome and an extraordinary measure of commitment. Program Manager Vince Rausch at Langley and Dryden Project Manager Joel Sitz both deserve great credit for fostering these attitudes.

No less important among the team's attributes was perseverance. The first X-43A flight failed, and it took great resilience on the part of the team members to bounce back from that flight, analyze the causes of failure and respond with two highly successful flights. The most recent flight added immeasurably to our data about flight near Mach 10, the operation of a scramjet engine and much more. Despite the initial setback and many others on the road to success, the team persevered.

EC04 0327-29 NASA Photo by Tom Tschida

*Dryden Center Director Kevin L. Petersen congratulates Dryden X-43A Deputy Project Manager Paul Reukauf on the successful X-43A mission.*

As former Dryden Center Director Ken Szalai noted, "Batting .667 in the hypersonic league is an all-star performance." Ken deserves much credit for getting the program started on the right foot with his initial negotiations with Langley. Ken also hit the nail on the head when he said, "It is probably the most important project done by NASA aeronautics in the past 25 years. ... This is an enormous achievement by an extremely talented and determined team. This program has altered the future in ways not yet understood or foreseen."

It is not yet clear where the success of the Hyper-X program will lead, but one thing is certain: Dryden's ability to push technology beyond known limits endures. While there are no specific follow-on projects on the horizon, in line with Sean O'Keefe's comment above, two successful flights of the X-43A should be very helpful in our efforts to help the Agency in carrying out its exploration vision. Thus, for a variety of reasons, the great success of the Hyper-X team is extremely gratifying. It constitutes both a fulfillment of Dryden's historic role in furthering high-speed flight and a steppingstone to Dryden's future, which we are all working to create.

# Researchers travel to Canada; new partnerships could result

Two Dryden researchers recently gave presentations at a workshop sponsored by the École de Technologie Supérieure (ETS) at the University of Quebec that could lead to future collaborative projects.

Marty Brenner and Sunil Kukreja, Dryden aerostructures branch (Code RS) researchers, were among those who led sessions during the event, held Oct. 25-29.

Brenner's presentation was entitled "Aeroservoelastic Robust Model Development and Linear-nonlinear Test Data Analysis of the Active Aeroelastic Wing (AAW)."

Kukreja, a NASA/U.S. National Research Council postdoctorate fellow at Dryden, discussed "Structure Detection of Nonlinear Systems."

Courtesy Photo

*Front row from left, Dryden aerostructures branch (Code RS) researchers Marty Brenner and Sunil Kukreja were among those invited to attend a Quebec workshop and give presentations in their areas of expertise. The opportunity could lead to partnerships between Dryden and Canadian aerospace researchers.*

In the future, personnel from Dryden and Canadian universities could collaborate on aeroelastic modeling procedures and control design of aeroservoelastic systems, which address problems in flutter suppression, adaptive notch filtering and identification-for-control techniques. Areas for potential partnerships include Flight Research Productivity Tool development and future Active Aeroelastic Wing flight experiments using intelligent flight controls concepts.

Brenner and Kukreja were invited to attend the event by ETS professor Ruxandra Botez, who specializes in aeroelastic modeling for control-oriented applications. The workshop was established through open invitation to the technological community of the Montreal area, and was attended by employees from Canada's Bombardier Aerospace Co., the National Research Council of Canada and students from area universities. The event highlighted enthusiastic interest in modeling, control and identification for aeroservoelastic systems, especially in the area of nonlinear data analysis and system identification.

The ETS Consortium for Research and Innovation in Aerospace in Quebec assisted with arrangements that made it possible for Brenner and Kukreja to attend.

Other activities included a visit to McGill University in Montreal with Benoit Boulet, a professor and resident expert in the field of aeroelasticity, aeroservoelasticity and robust control design. The Dryden researchers said the visits "opened channels of communication" related to generic flight test, aeroelastic modeling and identification and other flight control-oriented issues.

# News at NASA

## Cassini's radar reveals complex Titan surface

The first radar images of Saturn's moon Titan show a very complex geological surface that may be relatively young. Previously, Titan's surface was hidden behind a veil of thick haze.

"Unveiling Titan is like reading a mystery novel," said Dr. Charles Elachi, director of NASA's Jet Propulsion Laboratory, Pasadena, Calif., and team leader for the radar instrument on Cassini. "Each time you flip the page you learn something new, but you don't know the whole story until you've read the whole book. The story of Titan is unfolding right before our eyes, and what we're seeing is intriguing."

http://www.nasa.gov/mission_pages/cassini/media/cassini-102904.html

## NASA, Navy connect with Constellation

The age of sail met the future of space exploration Oct. 30 at the U.S. Naval Academy in Annapolis, Md.

NASA Administrator Sean O'Keefe joined Navy officials in a ceremony on board the historic frigate USS Constellation, which was docked at the academy.

Constellation Museum Director Chris Rowson presented O'Keefe with two historic pieces of planking from the 150-year-old vessel, highlighting the connection between the ship and NASA's Project Constellation, the Agency's new family of crew exploration vehicles, which will carry humankind back to the moon, on to Mars and beyond. One plank will fly on a future Shuttle mission and the other will be for display at NASA.

http://www.nasa.gov/vision/earth/everydaylife/okeefe_constellation.html

## Expedition 9 crew returns

International Space Station Expedition 9 crewmembers Commander Gennady Padalka and NASA Science Officer Mike Fincke landed on target Oct. 23 in the steppes of Kazakhstan at 8:36 p.m. EDT after 188 days in space.

Padalka and Fincke undocked their Soyuz capsule from the orbiting laboratory at 5:08 p.m. EDT and headed home. With them were Russian Space Forces Test Cosmonaut Yuri Shargin, who had come to the ISS with the Expedition 10 crew, Commander Leroy Chiao and Cosmonaut Salizhan Sharipov. Shargin spent eight days on the ISS performing scientific experiments.

http://www.nasa.gov/vision/space/features/exp9_landing.html

# Cook the bird well, cook it safely

Among the most enduring of holiday dining traditions is the ever-present turkey bird, as time-honored and venerable as Dryden's B-52B – though probably much tastier. (It's also much easier maneuvering a turkey onto the family dining table.)

But while a holiday bird may not be susceptible to dangers posed by fuel leaks or bald tires, there still are important safety issues to remember if turkey is on your menu this season. Dryden's safety officials remind employees to observe a few guidelines as they prepare the holiday feast:

*Fowl are susceptible to the growth of several types of bacteria, some of which can grow in as little as two hours. Turkeys should be thawed in the refrigerator, allowing one day of defrosting time for every five pounds of bird. Leave the turkey in its store wrapper and place it on the bottom rack of the refrigerator. Thawing in cold – not warm or hot – water is also safe, as long as the water is changed every 30 minutes to keep it cold. Allow 30 minutes per pound to defrost a turkey this way. Microwave thawing is another option, if the bird will fit in your microwave oven. But microwave thawing can create "hot spots," which may encourage bacterial growth. If thawed in a microwave, the turkey should be cooked immediately after thawing; do not refrigerate after thawing, for cooking later.

*Never stuff a turkey ahead of cooking time. In addition, do not prepare stuffing completely in advance; vegetables can be chopped and bread ingredients prepared, but liquids and/or moist ingredients should not be added until just before stuffing the turkey. Wash the turkey cavity thoroughly and remember to remove giblets before stuffing. Allow 1/2 to 3/4 cup of stuffing per pound of turkey and do not overstuff; in order to cook to a safe temperature, stuffing needs room to expand during cooking.

*Stuffing should be cooked to 165 degrees F. Raw juices often contain bacteria that may not be killed even when the turkey's internal temperature reaches 180 degrees F, the recommended internal temperature to be reached in order for the cooked meat to be eaten safely. Never cook a turkey at oven temperatures lower than 325 degrees F.

*Use a meat thermometer to measure doneness. Before cooking, insert the thermometer into the thickest part of the raw turkey's thigh, since dark meat takes longest to cook. Make sure the thermometer is not touching bone. If a meat thermometer is not going to be used, the turkey should not be stuffed.

*Most commercially available turkeys don't need basting. But if you do decide to baste your bird, be aware that uncooked or partially cooked juices may contaminate basting bulbs or other tools, so these should be cleaned frequently during the cooking period.

*The cooking process should never be interrupted since doing so could allow some types of bacteria to thrive. Allow the turkey to cook uninterrupted until the thermometer guarantees it is thoroughly done.

*If the turkey is done ahead of schedule, it may be safely held in the oven at 200 degrees F – leaving the thermometer in the bird to make sure the meat temperature does not drop below 140 degrees F during the holding period.

*Most families don't have a chef preparing their holiday dinner, so should use care when cooking fowl for their holiday feast.*

*Refrigerate leftovers within two hours of taking the turkey and stuffing out of the oven. Leftover turkey will keep safely for up to four days. Stuffing should be reheated to 165 degrees F.

Deep-fried turkeys are increasingly popular. If deep-frying is your preferred cooking method this year, heed these additional tips when dealing with the hot oil and the fryer:

*Make sure to put the fryer on a level surface to avoid spills or tipping.

*An all-purpose fire extinguisher should be kept on hand in the event your deep-frying experience should end in flames. Never use water to douse a grease fire.

*Most fryers are not equipped with thermostat controls; never leave a fryer unattended, as oil could heat to the point of catching on fire.

*Fryer lids and handles become extremely hot during and past the time they're in use. Make sure to have oven mitts and hot-pan holders readily accessible.

*Be sure the turkey is completely thawed before immersing in the oil. Water from a partially frozen turkey could cause sudden spills of oil over the side of the fryer.

And whatever method is used for cooking the bird, be sure and wash hands, cutting boards, utensils and counter tops thoroughly with soap before and after handling raw turkey. Wooden cutting boards should be avoided, and diluted bleach can be used to clean plastic, glass or marble boards.

No matter what's on the menu, a safe and happy holiday is the goal for every Dryden employee.

# CFC event on target

With the Dec. 15 deadline for participation still weeks away, Dryden employees already have exceeded last year's Combined Federal Campaign donations by more than $2,000.

"We're really, really pleased with how the Center has responded this year," said Dryden CFC coordinator Chris Naftel, a project manager in the Hyper-X program office.

As of Nov. 22, pledges by Dryden employees to the federal government's annual fund-raising program have totaled $95,200, surpassing the goal for this year's effort by $200. In addition, Naftel said fifty more employees than last year have pledged dollars to the CFC drive, in which civil service and contract employees of the U.S. government sign up for donations that are deducted from their paychecks.

Employees may continue signing up to participate in the campaign until Dec. 15 by contacting Naftel, ext. 2149.

CFC proceeds benefit a wide variety of area charities.


**Nov. 6, 1957** – Maj. Clyde Good delivered F-107A (55-5118) to NACA High Speed Flight Station. John B. "Jack" McKay flew the airplane for stability and control research flights.

**Nov. 2, 1960** – Bill Dana delivered JF-100C (53-1709) to the NASA Flight Research Center from NASA Ames Research Center for use in a variable-stability research program and airborne simulation studies in support of the X-15 and Supersonic Transport (SST) programs.

**Nov. 2, 1967** – Joseph S. Algranti delivered a SH-3A helicopter

**See Legacies, page 8**

# Dryden hosts 100 Space Grant directors

**By Katrina Emery**
Dryden Office of Academic Investments

On Oct. 21, Dryden played host to 100 Space Grant directors from across the U.S. Each year the National Space Grant College and Fellowship Program – commonly known as the Space Grant – convenes a conference for directors of the 52-state consortium. With more than 800 affiliates across the country, the Space Grant administers programs in research, education, workforce development and public outreach. More than 500 colleges and universities participate annually in the program, which provides some 2,000 student awards and 500 student-mentor programs.

Dryden Deputy Director Steven Schmidt kicked off the event with a presentation detailing Dryden's role in the NASA mission and the impact the Center has had in the field of aeronautics research. Other speakers included Robert Navarro, who discussed the Pathfinder Plus program, and Adam Matuszeski and James Mills on the F-18 Active Aeroelastic Wing. Afternoon sessions were led by Paul Reukauf, who spoke on the X-43/Hyper-X program; Ed Teets, weather; and Al Bowers, AERO Gravity Assist.

Participants closed the event with a reception hosted by Dryden's Aerospace, Education, Research and Operations (AERO) Institute and the City of Palmdale. The AERO Institute is a Dryden-developed project designed to foster partnerships among academia, government and industry by leveraging NASA's 15-year investment in the Space Grant program. Goals of the initiative include improving science and mathematics education and developing the aerospace workforce of the future. Partners include Dryden, the California Space Grant Foundation, the cities of Palmdale and Lompoc and private companies including Adobe Systems Inc., San Jose, Calif.

**EC04 0318-07** **NASA Photo by Tom Tschida**

*During a Dryden tour, Adam Matuszeski gives Space Grant directors a short lesson on the F/A-18 Active Aeroelastic Wing. The tour was part of a series of presentations designed to educate attendees about Dryden's role in NASA.*

# Launch! Lau

EC04 0325-12

EC04 0325-37 NASA Photo by Carla Thomas

EC04 0325-31

NASA Photo by Carla Thomas

EC04 0283-3 NASA Photo by Tom Tschida

*From left, Dryden X-43A Operations Engineer Dave McAllister, Dryden X-43A Chief Engineer Laurie Marshall and Dryden X-43A Project Manager Joel Sitz monitor the X-43A flight experiment's progress from the control room, above. At left, the three images show the "stack" being air launched from the NB-52B and the rocket booster igniting to take the X-43A to the test condition, where it fired its engine at speeds near Mach 10.*

# 10-9-8-7-6-5-4-3-2-1 nch! Launch!

NASA Photo by Carla Thomas

Launch! Launch! Launch!

Those were the words from Mission Control that launched the opening sequence of the X-43A research flight.

Beneath the wing of the NB-52B hooks released the rocket booster containing the X-43A, referred to as the "stack." The rocket booster descended gracefully and the rocket ignited. The powerful rocket sent the X-43A on its way, faster and faster, its yellow, red and white trail silhouetted against a canvas of a blue sky.

Higher and faster the stack went, until reaching the point where the X-43A separated from the booster and began its mission in earnest.

In a sequence that unfolded too quickly to be seen with the naked eye, a combination of explosive bolts and pistons pushed the X-43A from the booster so the supersonic combustion ramjet (scramjet) engine could fire. The firing of the revolutionary engine at speeds near Mach 10 provided scientists with more Mach 10 data than all previous research combined.

Once at test-condition speed, the X-43A engine cowl opened and burned fuel for about 10 seconds. About 20 seconds after opening, the cowl closed and the X-43A team began preparations for the experiment's next phase.

With the X-43A's fuel expended, the engine test was complete. But in the experiment's second half, researchers controlled the aircraft and initiated maneuvers using the vehicle's flight control surfaces in efforts to gain understanding of various aerodynamic forces at speeds from Mach 10 down to when the testbed reached its stopping point, in the ocean.

EC04 0327-23 NASA Photo by Tom Tschida

*Left to right, Langley Research Center's Charles McClinton, Dave Reubush and Hyper-X Project Manager Vince Rausch monitor the X-43A mission as it unfolds.*

Meanwhile, the NB-52B headed back to Dryden after successfully completing its final mission before a well-earned retirement.

It was a fitting final curtain for an aircraft that next summer will reach its 50th birthday. The NB-52B's first NASA mission was air launch of the hypersonic X-15, one of the most successful aeronautics projects in history, and the venerable bird ended its career with another groundbreaking research project, the hypersonic X-43A.

# A Center of Attention

## Hard work, dedication and an outstanding attitude make Marshall a success

**By Beth Hagenauer**
Dryden Public Affairs

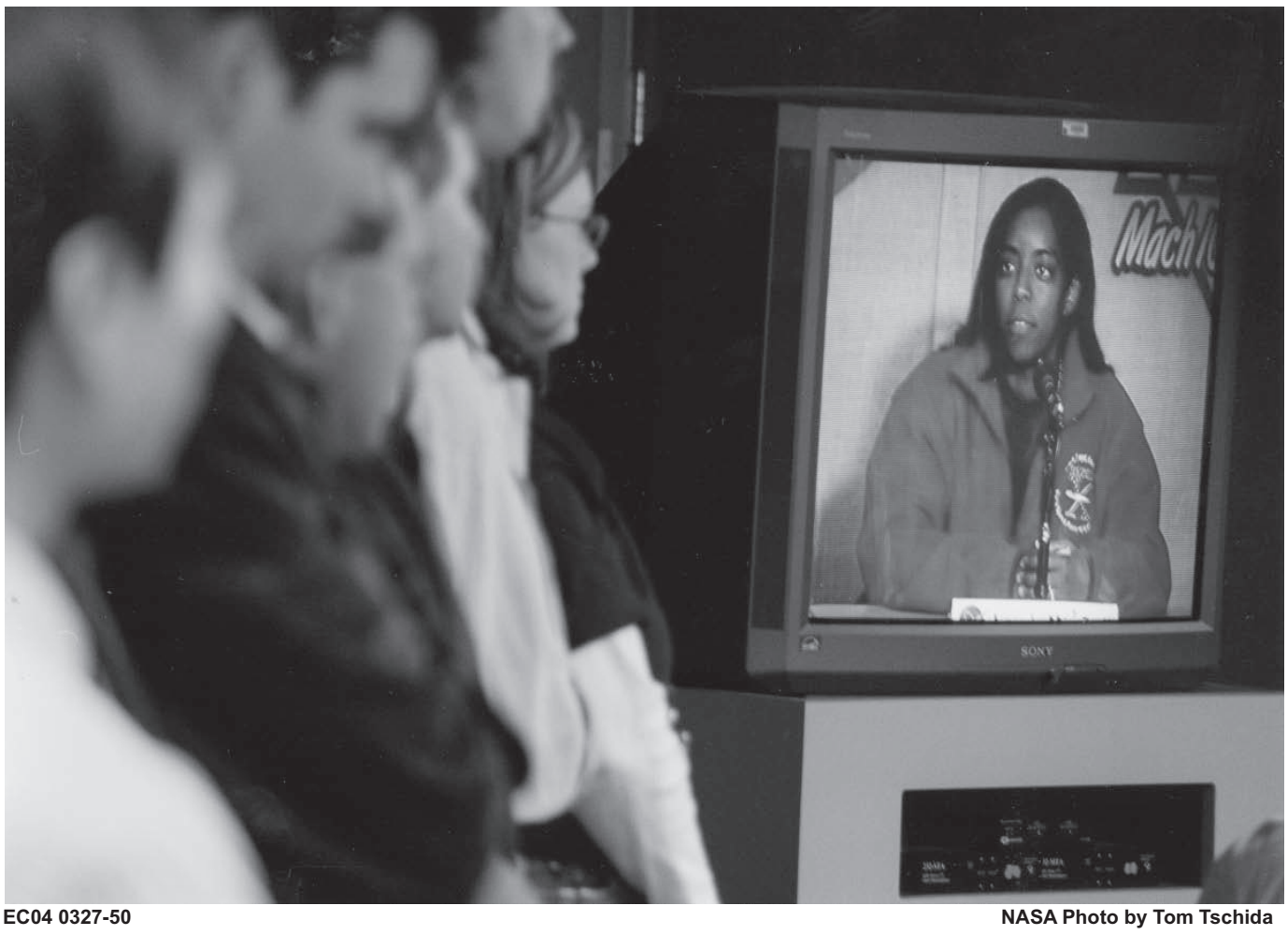
As a grade-schooler, one of Laurie Marshall's first science experiments was to observe the moon throughout the night. The experience convinced her that being part of space exploration would be a great adventure. Today, as a leader on a NASA project that could help make space exploration easier and less expensive, she's learned she was right.

Marshall and her colleagues on the X-43A project are exuberant after their recent success.

"The speed at which we accomplished (the third flight) was a real credit to the team we have," Marshall said. "It took us just eight months, after the second flight, to get the vehicle turned around and ready for flight," as opposed to the more than two years that lapsed between the first and second missions.

With the third flight, "we had new trajectories, a new controller for the research vehicle – because we were able to make use of the same team, we were able to do all that work in a short period of time," she said. "The experience base was there, and that's what allowed us to succeed. It speaks volumes about the quality of the team."

Marshall served as chief engineer for the third flight of the hypersonic X-43A research vehicle, a post she assumed in April 2004. Previously, she had been X-43A launch vehicle chief engineer and has served in various other experimental and science positions during her 14-year tenure at Dryden.



EC04 0327-50 NASA Photo by Tom Tschida

*Chief Engineer Laurie Marshall commands attention in a post-flight briefing after the X-43A's successful third flight. Marshall, a 14-year veteran of Dryden research work, served the project in various capacities before assuming the post of chief engineer in April. She credits the teamwork of the X-43A project staff for the quick turnaround time between the second and third mission flights.*

She was the principal investigator on the Advanced L-Probe Air Data Integration experiment, flown on the F-18 Systems Research Aircraft, which used air pressure to determine angles of attack and sideslip in addition to taking conventional air data measurements. She was an aerospace researcher on ship two of the F-16XL Supersonic Laminar Flow project and also participated in analysis of Space Shuttle maneuvers, work that

**See Marshall, page 8**

# Langley's Voland a familiar face at Dryden

## Voland's X-43A work meant regular bicoastal travel between two centers

**By Ashley Dow**
Langley Public Affairs

If it were not for the work ethic Randy Voland displayed as a NASA co-op student, he may never have had a career at Langley Research Center in Hampton, Va.

Voland's tenure as a Langley co-op student began in 1981 though he admits today that, at the time, he didn't find his work with space structure applications and aircraft noise reduction all that interesting. So, not wanting to continue the type of work he did as a co-op, he searched for jobs instead outside of NASA.

But shortly after graduation from North Carolina State University, Voland received a call from a Langley propulsion researcher who had been told about the hard work Voland put forward in his co-op experience. And even though the young engineer didn't really know much about propulsion, he was pleased to accept the offer of a job in Langley's Hypersonic Propulsion Branch anyway.

Today, he serves as the propulsion team lead for X-43A. In that post, he headed the team that designed and tested the craft's revolutionary scramjet engine, work that's meant shuttling back and forth between Dryden and Langley for the past five years. When the X-43A team's efforts paid off with a successful third flight Nov. 16, Voland numbered among the ranks of the ecstatic.

"Both (the second and third flights of the testbed) were just great," he said. "The X-43A performed pretty much just the way we expected them to."

Voland has been involved in the X-43A project since 1996. The same exhilaration he felt the day he was offered a position in the Propulsion Branch is evident today, in the wake of the project's final flight.

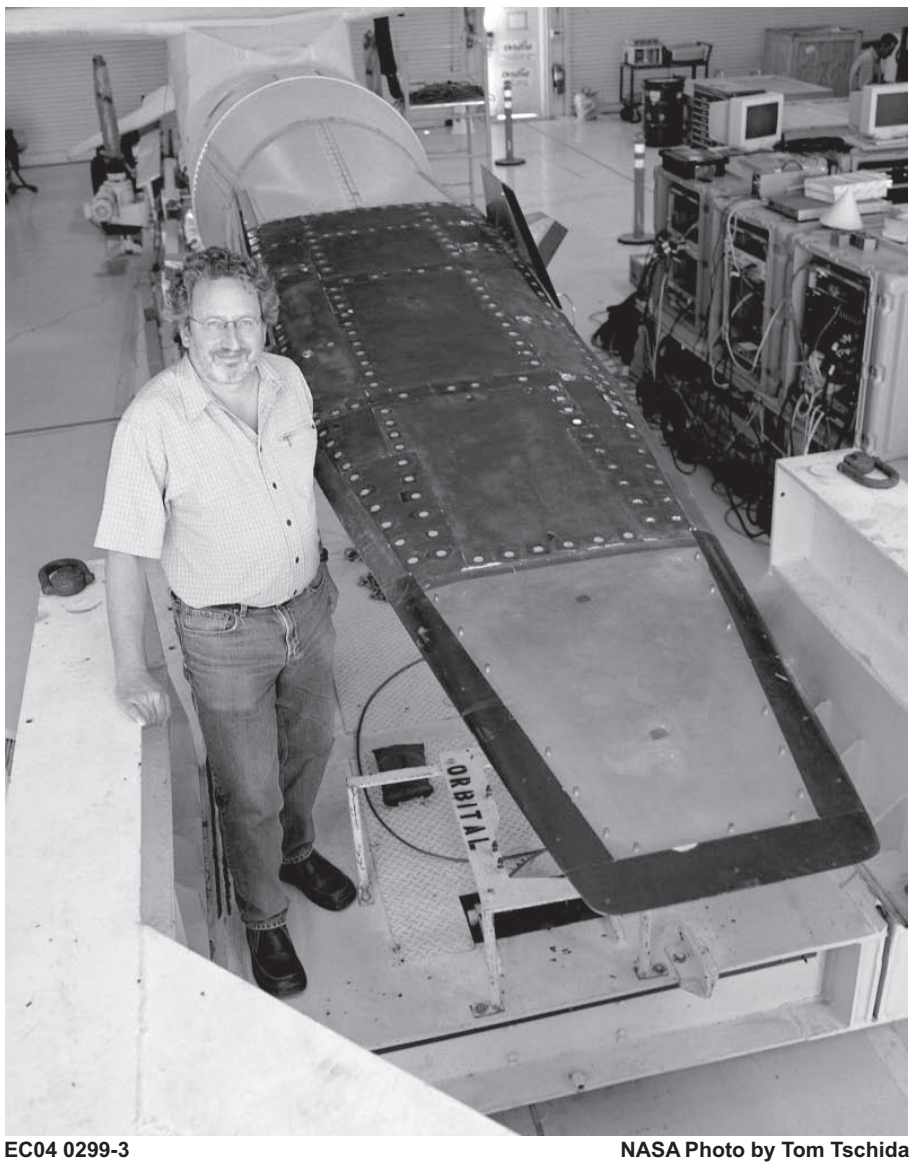
"X-43A is exciting because it's a flight project," he said. "It's a big deal to prove something in flight that actually works."

With the three X-43A missions, researchers hoped to prove the capabilities of a scramjet engine in flight. A problem with the booster rocket in the first flight occurred early in the mission, preventing the scramjet engine portion of the experiment from being initiated. Voland's team worked hard to re-evaluate everything before the second flight, determined to ensure success.

"We had to re-look at everything," he said. "We had a couple of minor things that we dealt with on our systems, and eventually made some changes with how the engine was operated. The changes were made so the engine would be less likely to flame out – or, un-start.

"We could prove the engine on the ground and in calculations, but we needed to prove it in the air. The success of the second flight answered a lot of questions for us."

**See Voland, page 8**




EC04 0299-3 NASA Photo by Tom Tschida

*Langley Research Center's Randy Voland has been a frequent flier between Langley and Dryden during his work with the X-43A.*

# Images of Success

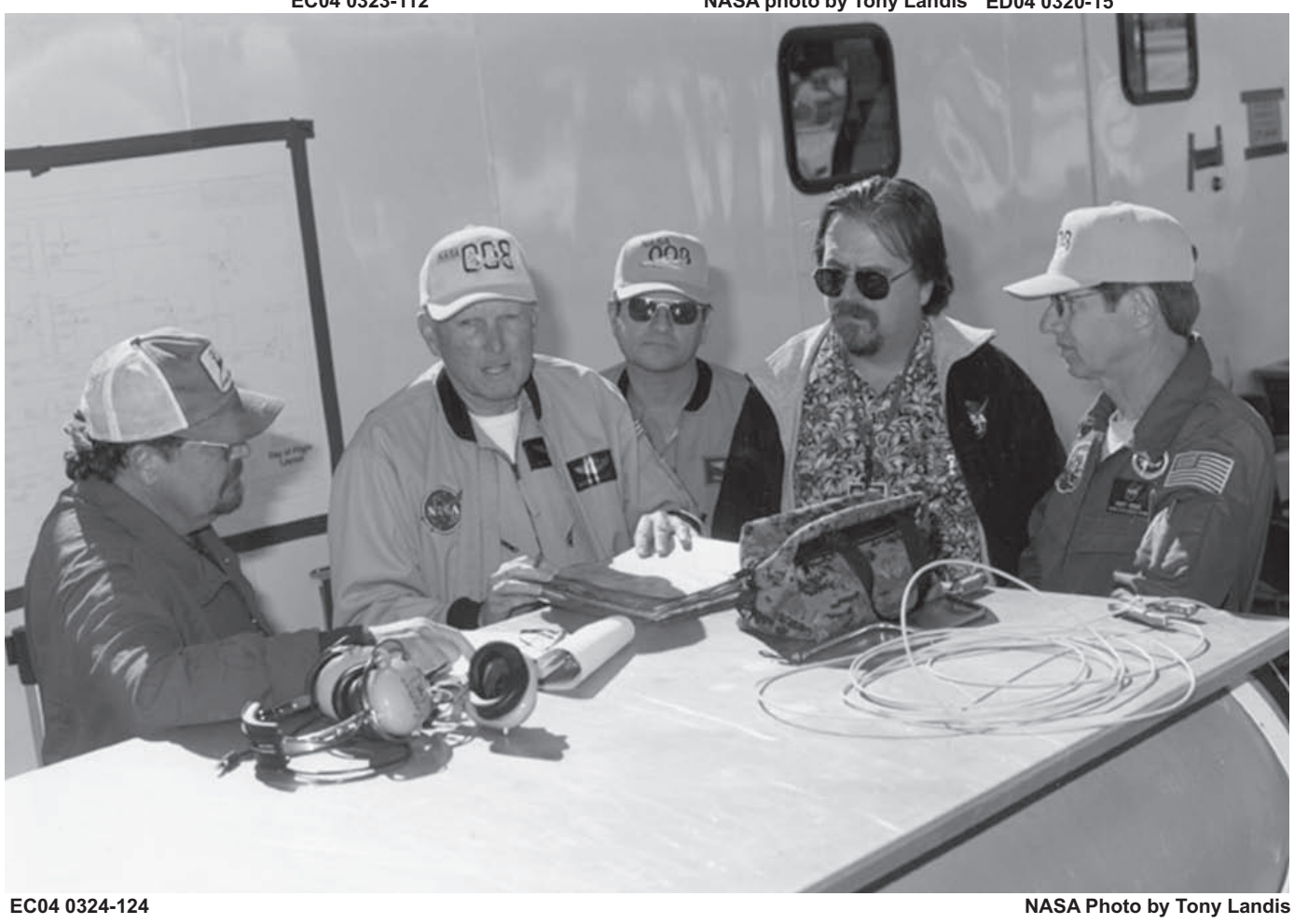
EC04 0326-2 NASA Photo by Carla Thomas

*At right, night crew members, from left, Ade Gordon, Clinton St. John, Shane Wilson and Gary Pacewitz look over the X-43A.*

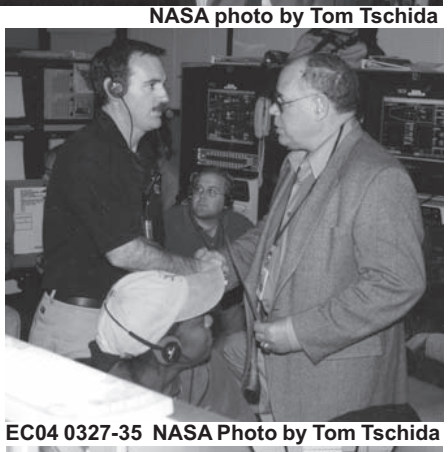
*Far right, Dale Edminister checks the vehicle prior to its mission.*

EC04 0323-112 NASA photo by Tony Landis

ED04 0320-15 NASA photo by Tom Tschida



EC04 0324-124 NASA Photo by Tony Landis



EC04 0327-35 NASA Photo by Tom Tschida

EC04 0327-32 NASA Photo by Tom Tschida

ED04 0320-20 NASA Photo by Tom Tschida

***Above,*** *from left, Mike Bondy, Gordon Fullerton, Frank Batteas, Matt Graham and Monte Hodges consult prior to the X-43A flight.* ***Right, top,*** *Dave McAllister is congratulated by NASA Deputy Administrator Frederick Gregory after the successful mission. Laurie Marshall is in the foreground and Clint St. John is in the background.* ***Right, center,*** *Victor Lebacqz, aeronautics research mission directorate associate administrator, shares a smile with Vince Rausch after the X-43A flight.* ***Right, bottom,*** *control room staff monitor the X-43A mission.*

## X-43A ... from page 1

what the X-43A flights mean for future NASA hypersonic research.

"We have a lot of data to look at now from two successful flights, a lot of wind tunnel data leading up to the flights, and CFD (computational fluid dynamics) data. We'll talk with our industry partners. We'll work our way through what we think we've learned to see what next steps might be, and talk about some foundational technology we might what to do," he said.

Randy Voland, a senior research engineer from Langley Research Center, Hampton, Va., explained "foundational technology" as smaller projects that can later lead to larger ones. In the case of possible follow-on research to the X-43A, foundational research could include ground tests of new engine technology that could later be integrated into a flight research vehicle that could take off under its own power and fly into the hypersonic realm, he said.

Sitz has a vision of what he thinks should happen next.

"The next step I'd like to see at NASA is to take a turbine engine and a ramjet or scramjet engine and combine those propulsion cycles and put some hardware together and start testing it," he said. "Maybe in a couple of years we could put an airplane around that technology. There are a lot of paths you can take from this point, and they all lead forward."

Laurie Marshall, Dryden X-43A chief engineer, explained the significance of the latest record flight.

"It was a phenomenal flight that looked just like some of the mission simulations we practiced. The data was captured longer than we predicted and we have quite a lot to look at for quite a long time," she said.

Voland agreed with Marshall and elaborated on the issue of data acquisition.

"This data set dwarfs all previous (Mach 10) data," he said. "Mach 10 research on the ground is measured in miliseconds; this time, the engine was open for 20 seconds (10 seconds during which fuel was fed into the engine), which dwarfs all Mach 10 data combined. Hopefully, we'll go beyond this (in future experiments). We can really do this stuff, and the vehicle works the way we thought it would."

Dave McAllister, X-43A operations manager for flight three, expressed officials' gratitude to the families of X-43A team members for the greatest sacrifice: the absence of loved ones during the long days and weeks and even longer weekends and holidays required to keep the project moving forward.

Supersonic combustion ramjet engines promise more airplane-like operations for increased affordability, flexibility and safety in ultra-high-speed flights within the atmosphere and for the first launch stage into Earth orbit. The advantage to scramjets is that once they are accelerated to about Mach 4 by a conventional jet engine or booster rocket, they can fly at hypersonic speeds, possibly as fast as Mach 15, without carrying heavy oxygen tanks, as rockets must.

The design of the engine, which has no moving parts, compresses the air passing through it so combustion can occur.

NASA Deputy Administrator Frederick Gregory congratulated the team after the flight.

"This is a very, very exciting time," he said. "It was a privilege to come out and see the B-52 launch a hypersonic vehicle for the last time. It was a very significant mark for NASA and those who support the effort. It really demonstrates a capability to do things people said were impossible. I'm proud of the team, and I congratulate them."

Hyper-X Program Manager Vince Rausch also was pleased with the X-43A's performance.

"It was really great to see that we once again made aviation history. We are absolutely elated. We had a great team at both centers (Dryden and Langley) and with our industry partners," he said.

The X-43A, atop the modified Pegasus rocket booster, took off from Dryden, attached beneath the wing of Dryden's historic B-52B launch aircraft. The booster and X-43A were released from the B-52B at 40,000 feet and the booster's engine ignited, taking the X-43A to its intended altitude and speed. The X-43A then separated from the booster and flew on scramjet power for a brief flight at nearly Mach 10.

Langley and Dryden jointly conduct the Hyper-X program. It is headquartered at NASA's aeronautics research mission directorate, from the Agency's Washington, D.C., headquarters. ATK-GASL (formerly Microcraft Inc.) of Tullahoma, Tenn., and Ronkonkoma, N.Y., built the X-43A aircraft and the scramjet engine, and The Boeing Company Phantom Works, Huntington Beach, Calif., designed the thermal-protection and onboard systems. The booster is a modified first stage of a Pegasus rocket built by Orbital Sciences Corp., Chandler, Ariz.

For more information about the Hyper-X program and the flights of the X-43A, visit http://www.nasa.gov/missions/researchlx43-main.html.

For information about NASA and Agency programs, visit http://www.nasa.gov.

## Marshall ... from page 6

resulted in expansion of the aeronautical database.

Early in her career, Marshall decided the best way to learn about different fields within aerospace engineering would be to personally experience as many of them as she could. She began that quest in 1989, as a student engineer in the Engineering Bureau of the Los Angeles City Department of Airports.

In 1990, she was an aerodynamics research assistant in the Minority Opportunities in Research Engineering program at the University of California at Davis. She then interned in 1990 as a technical staff undergraduate in the structural technology division of the Aerospace Corp., a California-based nonprofit research and development firm. Her NASA career began with a 1992 internship in Dryden's aerodynamics branch, which led to a full-time post at NASA after graduation, beginning in 1993.

Though she's opted out of the family business – practicing law – Marshall argues that it's flying that's in her blood. She grew up around and in airplanes. Her father got his pilot's license the year she was born, a milestone she feels may have destined her for a career involving aircraft. She also is a private pilot with an instrument rating.

Marshall chose a NASA career because she felt "the Agency was always working on cutting-edge research," and because her early dreams about space exploration never lost their allure.

Marshall is a graduate of the University of California at Davis with a Bachelor of Science degree in aeronautical and mechanical engineering. She earned an Engineer-in-Training license in 1994 from the California Board of Professional Engineers and a Master of Science degree in mechanical engineering in 1998 from California State University at Fresno.

Marshall's advice for young people is all about the value of stick-to-it-iveness.

"One thing I've learned is that you should never let anyone tell you that you can't do something," she said. "Even if it seems difficult, if it's something you really want to do, stay with it."

## Legacies ... from page 3

(149723/NASA 933) to NASA Flight Research Center from the Manned Spacecraft Center (now Johnson Space Center) in Houston, Texas.

**Nov. 4, 1973** – Don Mallick delivered a Bell 47G helicopter (N822NA) to NASA Flight Research Center from Houston. The four-day, 1,500-mile journey took 25.5 flight hours and required nine refueling stops along the way. The average ground speed was 52 miles per hour.

**Nov. 18, 1975** – Don Mallick delivered JF-104A (55-2961/N818NA) to Andrews Air Force Base, Va., for placement in the National Air & Space Museum.

**Nov. 7, 1979** – Col. James Sullivan and museum director Col. Richard Uppstrom delivered YF-12A (60-6935) to the U.S. Air Force Museum at Wright-Patterson Air Force Base, Ohio, following a joint NASA-USAF research program that spanned nearly10 years

## Voland ... from page 6

With the second flight behind them, Voland and his team then adjusted to changes the third flight would mandate. One big difference the team had to overcome was what the jump in target speed from Mach 7 to Mach 10 would mean for the scramjet.

"The engine operates quite differently at Mach 10. So we had a lot of preliminary calculations and tests that were used to finalize a propulsion database," he said, referring to the database that would be used to determine how much force the engine would be required to exert at various conditions.

The X-43A project was designed to prove that a scramjet engine could power a real plane, and accelerate. According to Voland, X-43A is only a small step in proving the viability of the scramjet engine.

"To me, the next big step would be making these vehicles reusable and discovering how we transition from a low-speed propulsion system to a high-speed propulsion system in flight."

He believes if the transition can be made successfully and the aircraft can take off from the ground, the engine system will be proven for such potential applications as the first stage of a two-stage space launch vehicle or for commercial air travel.

Voland's involvement with X-43A and the resources available to him through NASA have kept him working at Langley.

"I've worked with a lot of companies and universities, but the facilities and people at Langley have the potential to do and create amazing things," he said. "It's still one of the best places to work."

In addition to his involvement with X-43A, Voland currently is working toward his master's degree in bioengineering from Arizona State University.

The X-PRESS

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