



# Frontiers

[www.boeing.com/frontiers](http://www.boeing.com/frontiers)

JUNE 2011 / Volume X, Issue II



## Mission accomplished

After completing the International Space Station and flying more than 130 missions, the space shuttle program draws to a close

# 16 Homeward bound

In July 1972, NASA awarded North American Rockwell, a Boeing heritage company, a contract to build the first of the space shuttles. Today, nearly 40 years later and having blazed important trails in the exploration of space, the shuttle program is coming to an end. It has shaped many Boeing careers and left a remarkable record of accomplishment. Even though the journey is almost over for the shuttles, Boeing engineers are working on what could be next. This commemorative issue includes a pull-out poster featuring highlights of the program.

COVER IMAGE: FLAME AND SMOKE BLOW FROM THE THREE MAIN ENGINES AND THE TWO SOLID ROCKET BOOSTERS OF SPACE SHUTTLE ENDEAVOUR AS IT BLASTS OFF FROM THE NASA KENNEDY SPACE CENTER IN FLORIDA IN JULY 2009. NASA

PHOTO: GUESTS AT THE KENNEDY SPACE CENTER VIEW THE LAUNCH OF SPACE SHUTTLE ATLANTIS IN NOVEMBER 2009. ATLANTIS WILL MAKE THE SHUTTLE PROGRAM'S FINAL FLIGHT, TENTATIVELY SCHEDULED FOR JULY. NASA



## THEIR MEMORY MARCHES ON.

The people of Boeing honor those who gave their lives for our country's freedom. We will always be grateful.



## Ad watch

The stories behind the ads in this issue of *Frontiers*.

*Inside cover:*



Boeing pays tribute to those who gave their lives defending freedom. Part of an integrated campaign, this Memorial Day print ad ran in *The Washington Post*, *Washington Times* and *Seattle Times*, as well as in regional, trade

and military publications. The campaign also featured complementary TV and online components.

*Page 6:*



This *Flight International* ad was developed to recognize the winner of the Boeing-sponsored Engineering Student of the Year Award. Part of the Flightglobal Achievement Awards, it recognizes an outstanding student

working on aeronautical or space technology.

*Pages 12–13:*



Created for the 2011 Boeing Global Supplier Conference, this ad was designed to congratulate the 2010 recipients of the Supplier of the Year awards and reflects the conference theme of "Shaping our success—creating a shared vision."



# Frontiers

**Publisher:** Tom Downey  
**Editorial director:** Anne Toulouse

## EDITORIAL TEAM

**Executive editor:**  
Paul Proctor: 312-544-2938

**Editor:**  
James Wallace: 312-544-2161

**Managing editor:**  
Vineta Plume: 312-544-2954

**Art and design director:**  
Brandon Luong: 312-544-2118

**Graphic designer:**  
Cass Weaver: 480-216-4539

**Photo director:**  
Bob Ferguson: 312-544-2132

**Commercial Airplanes editor:**  
Don Smith: 206-766-1329

**Defense, Space & Security editor:**  
Diane Stratman: 562-797-1443

**Engineering, Operations & Technology editor:**  
Junu Kim: 312-544-2939

**Human Resources and Administration editor:**  
Geoff Potter: 312-544-2946

**Shared Services Group editor:**  
Beriah Osorio: 425-577-4157

**Staff writer:**  
Eric Fetters-Walp: 425-266-5871

## ONLINE PRODUCTION

**Web manager:**  
Wendy Manning: 312-544-2936

**Web designer:**  
Michael Craddock: 312-544-2931

**Web developers:**  
Lynn Hesby: 312-544-2934  
Keith Ward: 312-544-2935

**Information technology consultant:**  
Tina Skelley: 312-544-2323

## HOW TO CONTACT US:

**E-mail:**  
boeingfrontiers@boeing.com

**Mailing address:**  
Boeing Frontiers  
MC: 5003-0983  
100 N. Riverside Plaza  
Chicago, IL 60606

**Phone:**  
312-544-2954

**Fax:**  
312-544-2078

**Web address:**  
www.boeing.com/frontiers  
Send all retiree address changes to  
Boeing Frontiers, MC 3T-12  
P.O. Box 3707  
Seattle, WA 98124-2207

**Postmaster:** Send address corrections to  
Boeing Frontiers, MC 3T-12  
P.O. Box 3707, Seattle, WA 98124-2207  
(Present addressees, include label)

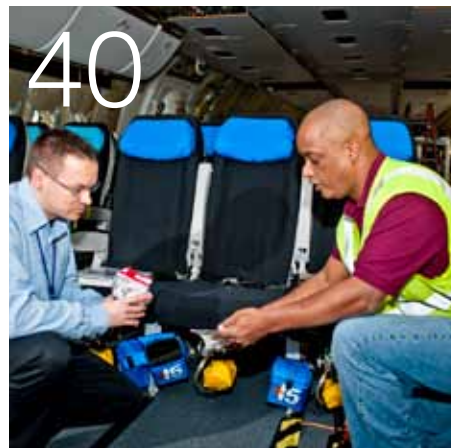
# table of contents



38

## Be safe out there

From a “zero gravity” mechanical arm that makes it easier for employees to sand paint on the underside of an airplane wing to a no-touch pressure washer that speeds the cleaning of Boeing facilities, new technology is being developed and deployed throughout Boeing to help reduce workplace injuries. Using ergonomic tools and processes, Boeing is improving the design—and efficiency—of work. PHOTO: GAIL HANUSA/BOEING



40

## Ready for the show

The world’s aerospace community this month heads to Paris and the biggest air show of them all, where a number of Boeing products will be on display. Making sure these get to the show on time and ready for safe public display is no small undertaking. This job falls to Boeing Test & Evaluation teams, who are responsible for everything from aircraft routing to providing a safe display area. PHOTO: JIM ANDERSON/BOEING



44

## World-class

The Boeing Company is nearly 100 years old and has grown from a small seaplane-making business on the shores of Seattle’s Lake Union to an aerospace giant with operations around the world. Whether the focus is on commercial jetliners, military aircraft or leading-edge research and development, the company’s strategy for success in today’s global economy is a “One Boeing” approach—marked by collaboration and partnerships that provide customers the best products at affordable prices. PHOTO: BOEING



14

## Reading, writing & robots

Student teams from around the globe design, test and then compete their robots in a Boeing-sponsored event that is not only fun but helps inspire young people to choose technical, scientific and engineering careers. The excitement of the competition is captured in this photo essay. PHOTO: BOB FERGUSON/BOEING



51

## Leading by design

Since the Next-Generation 737 entered commercial service in the late 1990s, Boeing engineers have continued to find ways to increase its value to customers through greater efficiency, performance and reliability. It’s all part of the never-ending effort to make sure the workhorse 737 stays ahead of the pack. PHOTO: MARIAN LOCKHART/BOEING

## INSIDE

### 07 Leadership Message

The Paris Air Show takes place this month, and a number of advanced Boeing products are scheduled to be on display. These programs reflect Boeing’s ability to operate as a global company, one that is focused on innovation and collaboration and that embraces change, says Shep Hill, president of Boeing International and senior vice president of Business Development and Strategy.

### 08 Snapshot/Quotables

### 09 Why We’re Here

### 53 Milestones

### 59 In Focus

## CORRECTION

On Page 19 of the May issue, an employee volunteer in the Earth Day photo essay was misidentified. In the top left photo, the employee on the right is Bob Lull.

# ENGINEERING STUDENT IS THIS YOUR YEAR TO SHINE?



## BOEING ENGINEERING STUDENT OF THE YEAR

The Boeing Engineering Student of the Year Award recognizes the achievement of an outstanding engineering student working on aeronautical or space technology. This prestigious Flightglobal Award, sponsored by The Boeing Company, recognizes the potential impact of a candidate's work on current or future technology.

In addition to industry recognition of this honor, the winner will receive the award at the Flightglobal Awards ceremony to be held at the Dubai Airshow on November 12, 2011. The competition is open to any engineering student currently enrolled in a program leading to a recognized academic degree. The submission deadline is September 19, 2011. For more information and entry details, go to [www.flightglobal.com/student](http://www.flightglobal.com/student). Don't miss your chance to engineer the future.

For more information or to enter now go to:  
[www.flightglobal.com/student](http://www.flightglobal.com/student)



# Embracing change

Boeing heads into the Paris Air Show focused on innovation, collaboration and productivity

**B**oeing and the aerospace industry are operating in an era of relentless change that is creating both global opportunity and competitive challenge. The scope and velocity of this change is transforming the way we live and the way we think about the future.

And this change is not limited to aerospace. It took about 38 years for the radio to reach a market audience of 50 million people. Television needed just 13 years. The Internet took four years, and Facebook only two years. The speed, reach and impact of technology and innovation have raised expectations and aspirations around the world.

Boeing's successes in both shaping and adapting to change will be on display during the biennial international Paris Air Show held in France this month. Innovative Boeing products we are scheduled to show include the new 787 and 747-8 Intercontinental jetliners; the world's most advanced airlifter, the C-17; and the F-15 multi-role fighter, which Boeing continues to keep affordable and effective by optimizing its proven design with new technologies and systems.

These programs represent Boeing's unique ability not only to adapt to market dynamics but to shape those dynamics as a single, integrated company. And our recent win on the KC-46A Tanker program for the U.S. Air Force demonstrates that a "One Boeing" approach is a competitive differentiator. This same approach of drawing on the talents and expertise of the enterprise, of partnering and collaborating globally, has accelerated success in the international marketplace for both Boeing Commercial Airplanes and Boeing Defense, Space & Security.

So where do we go from here? George Bernard Shaw said, "Progress is impossible without change." As Boeing employees and leaders, we can and should embrace change and ensure it results in progress for our company and our world—as the company has done for 95 years. By adapting and collaborating we can drive innovation, enhance productivity, and create the breakthrough

## Leadership Message



*"By adapting and collaborating we can drive innovation, enhance productivity, and create the breakthrough products and services that serve our customers."*

— Shep Hill

President, Boeing International  
Senior vice president, Business Development and Strategy

PHOTO: BOB FERGUSON/BOEING

products and services that serve our customers and that have made us the best aerospace company in the world.

As you read through this issue of *Frontiers* you will see examples of Boeing's innovative new products and services, and how we leverage the best of Boeing by operating as a single, cohesive global unit. Together, these efforts fuel our ongoing drive to be the strongest, best and best-integrated aerospace-based company in the world—for today and tomorrow.

*L'avenir est entre nos mains*—the future is what we make it. ■

DAWN'S EARLY LIGHT

Boeing Joint Direct Attack Munitions, or JDAMs, are ready to be loaded on a B-1B Lancer bomber in late March by airmen from the 28th Aircraft Maintenance Squadron at Ellsworth Air Force Base in South Dakota. The bomber, a ghostly image in the night floodlights, was being prepared for a mission in support of Operation Odyssey Dawn in Libya. This year alone, Boeing received multiple contracts valued at nearly \$190 million to supply the U.S. military with 7,500 JDAM tail kits and 700 new Laser JDAM sensors to convert existing unguided free-fall bombs into precision-guided weapons. In May, Boeing reached the 250,000 mark for precision-guided munition orders since the JDAM program started in 1998. PHOTO: U.S. AIR FORCE



# Get comfortable

Focus on office ergonomics reduces injury risks and helps improve quality of life

By Judy Kimball



As a workplace safety administrator, Judy Kimball takes advantage of every opportunity to make a difference for employees in Everett, Wash. In this *Frontiers* series that profiles employees talking about their jobs, Kimball discusses her commitment, and that of her team, to reducing ergonomic risks for office workers. PHOTO: GAIL HANUSA/BOEING

Quotables

“She’s got a lot of life left in her, but that’s not meant to be.”

– NASA launch director Mike Leinbach, as quoted in a Reuters story about the final flight of Space Shuttle Endeavour on May 16. NASA’s shuttle fleet is being retired. For more on this remarkable program that spanned some four decades, see stories and photos beginning on Page 16.

“The WTO has rendered its final verdict, and now Europe must comply within six months.”

– Boeing Executive Vice President and General Counsel J. Michael Luttig in a May 18 Boeing news release about the final World Trade Organization ruling on illegal aircraft development subsidies.

work with a dedicated team of ergonomic evaluators and we’re all committed to helping employees feel better and preventing ergonomic injuries.

As a safety administrator in Everett with Environment, Health and Safety, I am responsible for the Office Safety and Office Ergonomic programs. I define ergonomics as the science of making things comfortable and efficient. Our team’s goal is to provide a comfortable working environment for employees.

Boeing has thousands of office workers in Everett, and our team assists any employee requiring our services. Our more than 40 ergonomic evaluators are all volunteers who participate in this program in addition to their full-time jobs. Their commitment and dedication is amazing.

Our program has helped reduce discomfort, injuries and fatigue—and has even increased productivity. Most of all, it can help give our employees a better quality of life.

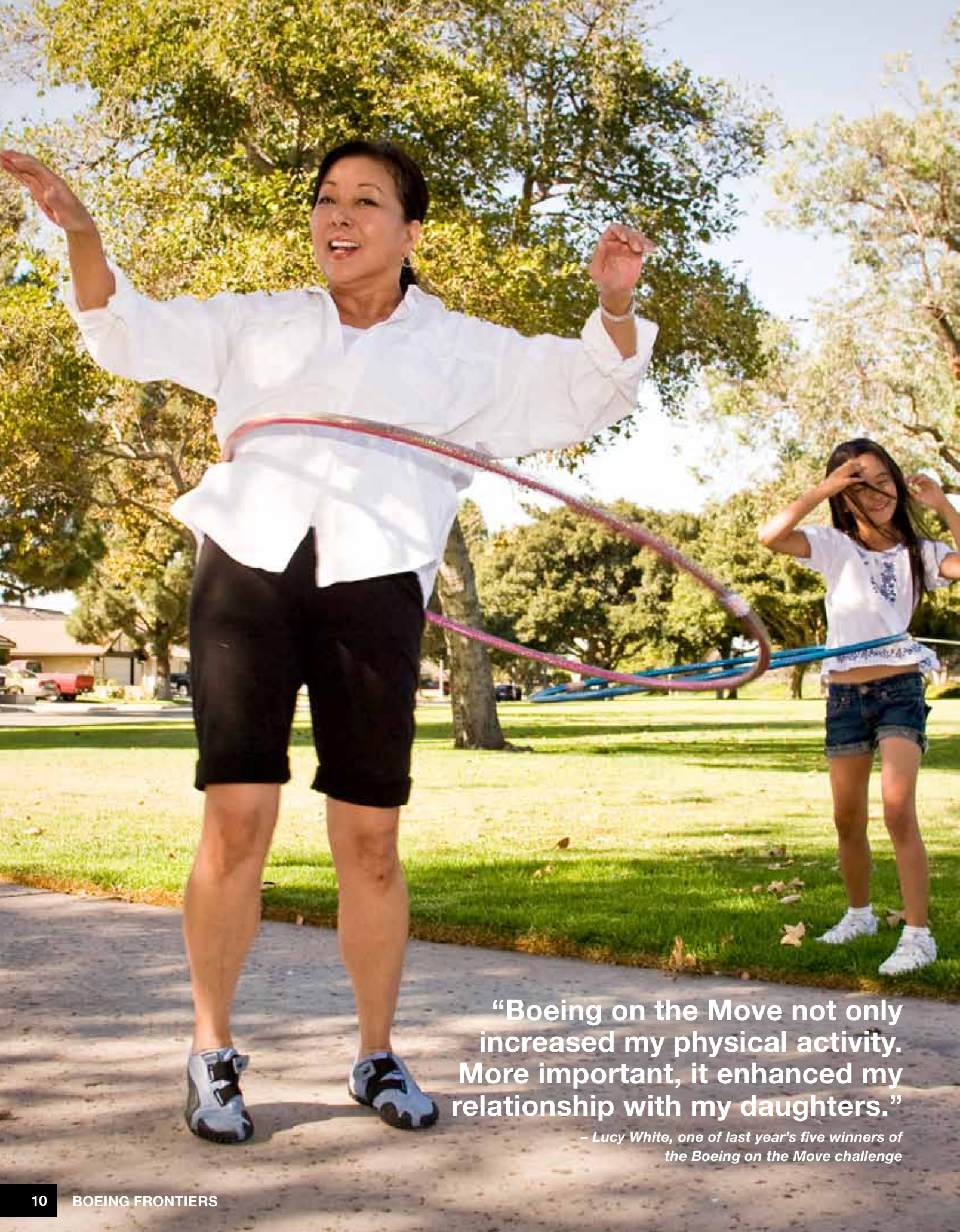
Typical ergonomic concerns for office workers are aches,

pains or strains in shoulders, backs, necks, wrists and arms. Employees seeking an ergonomic evaluation start with the self-help checklist on the Boeing Enterprise Ergonomics System on the Boeing intranet. Last year, 2,682 employees in Everett completed the checklist, and we conducted 1,500 one-on-one ergonomic evaluations.

In the course of our work, team members partner with Site Services and Supplier Management to provide equipment such as office chairs, computer peripherals and adjusted work surfaces as quickly as possible. I also work with the Disability Management and Vocational Rehabilitation organizations for more complicated cases that sometimes go beyond equipment changes.

Receiving emails from employees saying things like, “This new equipment changed my life,” or “I no longer have pain in my wrist and arms,” gives our team members, and me, a great feeling—knowing that we have made a difference. ■

[judy.a.kimball@boeing.com](mailto:judy.a.kimball@boeing.com)



**“Boeing on the Move not only increased my physical activity. More important, it enhanced my relationship with my daughters.”**

*– Lucy White, one of last year’s five winners of the Boeing on the Move challenge*

# Return engagement

Boeing on the Move will again be a fun way for employees to get moving—and get healthier **By Susan Birkholtz**

**F**or Kathy Haynes, a production coordinator for the company’s satellite business in El Segundo, Calif., the Boeing on the Move physical activity challenge last year was a life-changing experience.

It’s back for 2011. And Haynes, like many other Boeing employees around the globe, is eager to get started—again.

“I never considered just walking as a form of exercise to improve my health. I always thought you had to run,” said Haynes, who can’t run because she has prosthetics in both knees.

Haynes said she benefited from last year’s program in two ways: She now walks at home in the evenings, and she walks more at work than she did before she signed up for Boeing on the Move in 2010.

“I highly recommend this program to all of our employees who want to work on preventive health lifestyle changes,” she said.

More than 40,000 employees participated in the six-week challenge in 2010, the first year it was offered. The goal is 50,000 participants this year. U.S. and international employees—and employees on international assignment—will participate concurrently.

“The company invests in programs like Boeing on the Move because getting more physically active is one of the best things we can do for our health and well-being,” said Rick Stephens, senior vice president, Human Resources and Administration. “The challenge offers a fun and easy way for employees to get moving and make physical activity a part

of their daily routine. We hope even more employees will ‘choose to move’ with Boeing on the Move this year, either as part of a team or on an individual basis.”

Last year, 57 percent of those who responded to Boeing’s online Health Assessment said they were not getting adequate amounts of physical activity. Boeing on the Move helped change that. So will its return.

“I’m so excited that it’s coming back!” said Vicky White, a delivery manager with Learning, Training and Development Engineering Training in Renton, Wash. “Boeing on the Move gave my exercise routine an added boost, which I didn’t realize I needed or was missing until I became part of a team.”

One of last year’s five winners was Lucy White, a Customer Relations specialist and meeting and event planner in Long Beach, Calif.

“Boeing on the Move not only increased my physical activity,” she said. “More important, it enhanced my relationship with my daughters. I went from being a spectator to being a participant in their activities.”

For some employees, Boeing on the Move is an opportunity to help them drop unwanted pounds, as well as get healthier through activity.

“I have been on a weight-loss journey for the past three years, and participating in Boeing on the Move was the perfect way to garner support from others in the office,” said Kathe Jackson, a business and planning analyst in Oklahoma City.

“We formed a team and walked

together each day,” she said. “Even after the program ended, we continued to walk and use our pedometers. I think we are all feeling healthier and definitely plan to participate in the new Boeing on the Move challenge. I would recommend the program to all Boeing employees as a way to get moving, lose weight and make some new friends along the way!” ■

*susan.l.birkholtz@boeing.com*

## DATES TO REMEMBER

**JUNE 10:** Registration ends. After registering, you will receive a pedometer to track your daily activity.

**JUNE 20:** Six-week challenge begins. Track activity daily using an online tracking tool on the Boeing on the Move website. Or use a downloadable spreadsheet from the site to keep track of activity daily by hand.

**JUNE 26:** Last day to change your personal goal, create a team or join an existing team.

**JULY 31:** Challenge ends.

**AUG. 7:** Last day to enter activity online.

*For more information, visit [Boeing TotalAccess](#) and click “My Well Being” to access the [Boeing on the Move](#) website.*

**PHOTO:** Lucy White, a Customer Relations specialist and meeting and event planner in Long Beach, Calif., is pictured here with her daughter, Payton. BOEING

**REALIZING POTENTIAL. REWARDING SUCCESS.**

**Congratulations to our 2010 suppliers of the year.**

Their vision and superior performance have helped us achieve a shared success.

AMI Metals, Inc.

Bridgestone Corporation

CFM International

CSIRO

Delaware Resource Group of Oklahoma, LLC

Genesis Performance Systems, Inc.

Giga-tronics Microsource Division

GM Nameplate Inc.

Infotech Enterprises

Kawasaki Heavy Industries, Ltd.

KOREA AEROSPACE INDUSTRIES, LTD.

Pugh Capital Management, Inc.

Serco Inc.

University of Sheffield-AMRC

Valent Aerostructures-DACA Division, LLC

Vector Aerospace Helicopter Services UK

To learn more about recognition programs or for a list of the 2010 Performance Excellence Award recipients, visit [boeingsuppliers.com/recognition](http://boeingsuppliers.com/recognition)





# Day of the ROBOTS

From these robotic competitions for students could come Boeing engineers of tomorrow

By Peter Pedraza and photos by Ron Bookout and Bob Ferguson



“When you excite students with hands-on learning experiences, success soars. These young innovators will solve the problems we don’t even know exist yet.”

– Rick Stephens, senior vice president of Human Resources and Administration

For four days in April, more than 10,000 of the smartest and most creative students from all over the world competed head to head in a most unusual arena.

But this was no academic or athletic competition, even though the atmosphere resembled a sporting event with cheering and sign waving from the sidelines.

Rather, the contest involved robots, designed and built by students under the guidance of mentors, performing set tasks in competition with other teams’ robots.

Eduardo Fernandez, a senior at Carl Hayden High School in Phoenix, was part of a student team mentored by Boeing employee Daniel Palomino and aptly summed up his experience: “FIRST is so fun. I plan to major in

mechanical engineering. I want to do this the rest of my life!”

What is FIRST? It’s the nonprofit organization For Inspiration and Recognition of Science and Technology. FIRST’s worldwide robotic competitions for kids ages 14–18 is one way Boeing and its employees are providing young people with the inspiration and knowledge they need to become tomorrow’s technical workers—and candidates for Boeing’s future workforce.

“I believe we will see future Boeing engineers coming out of the FIRST program,” said Dennis Muilenburg, president and CEO of Defense, Space & Security. He attended the late April FIRST Robotics Championship in St. Louis.

Before the championships, more than 150 teams supported by Boeing grants

and mentors participated in regional competitions across the United States. Twenty-nine of those teams earned a spot in the finals.

“Employees serving as mentors are helping prepare students to meet future challenges and shaping the future of innovation,” said Rick Stephens, senior vice president of Human Resources and Administration.

Boeing has long supported FIRST through grants and educational scholarships, and with volunteers.

“When you excite students with hands-on learning experiences, success soars,” Stephens added. “These young innovators will solve the problems we don’t even know exist yet.” ■

*peter.p.pedraza@boeing.com*



**PHOTOS:** (Far left) Boeing-mentored competitors Hayden Vrbka, left, and Jeff Cottrell compete on the FIRST Robotics playing field with their robot, “Cahuna-Cat.” (Top insets, from left) Boeing Defense, Space & Security President and CEO Dennis Muilenburg talks with Eduardo Fernandez about the robot “Dulce’s Dream”; Nate Lindgren, left, and Boeing mentor Marc Sklar troubleshoot their robot, “2.0.” (Above insets) FIRST Robotics competitors add to the excitement with festive team costumes.



# TO **BOLDLY** GO

The space shuttle program has had a remarkable run that has spanned more than three decades and helped shape many Boeing careers

*By Bill Seil*

The space shuttle and its essential role in the assembly of the International Space Station have defined the Space Age for a full generation.

The first shuttle to orbit Earth, *Columbia*, was launched 30 years ago, on April 12, 1981. When *Atlantis* makes the final shuttle flight, tentatively scheduled for July, it will mark the end of a remarkable chapter in the history of space exploration and discovery—one that Boeing and its heritage companies helped write.

While lacking a dazzling climactic moment of success, such as the Apollo 11 moon landing, the space shuttle has gradually and forcefully transformed the ability of humans to live, build and respond to challenges in space. It has also set the stage for future lunar and interplanetary missions.

John Mulholland, vice president and program manager, Boeing Space Shuttle

***“It’s going to go down as a remarkable achievement and its legacy will be very strong. It’s been inspirational to the nation, and its success has made an enormous contribution to our future in space.”***

*— John Mulholland, vice president and program manager, Boeing Space Shuttle Program*

**PHOTO:** *Columbia* lifts off from Kennedy Space Center on the first shuttle flight into space in April 1981. NASA



Program, said the shuttle has revolutionized human access to space. It has also created an important base of knowledge, he noted, in moving forward on programs such as Commercial Crew transportation and, eventually, exploration beyond low Earth orbit.

“The beautiful thing about the shuttle is its unique combination of crew and cargo access,” Mulholland said. “On mission after mission, it has demonstrated that human beings can perform tasks that can’t be done by robotics. The repair of the Hubble Space Telescope is a good example.”

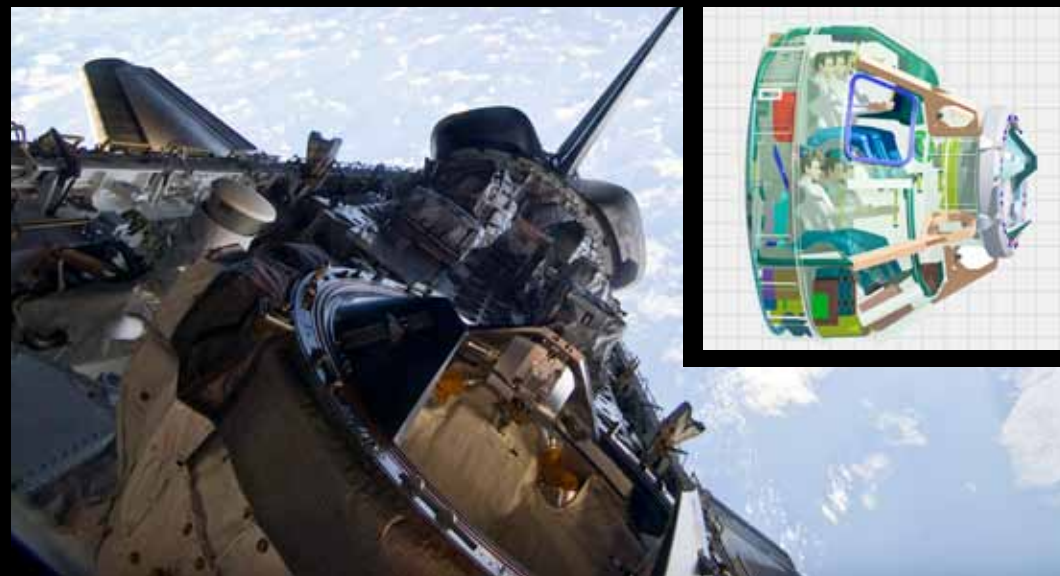
Boeing is well-positioned to take a leadership role in both near-term and long-term space exploration, Mulholland said. In the near term, the International Space Station, or ISS, for which Boeing is the prime contractor, has years of useful service ahead. Boeing also is competing to build the Commercial Crew vehicle for NASA, which will transport astronauts to and from the ISS and other low Earth orbit destinations.

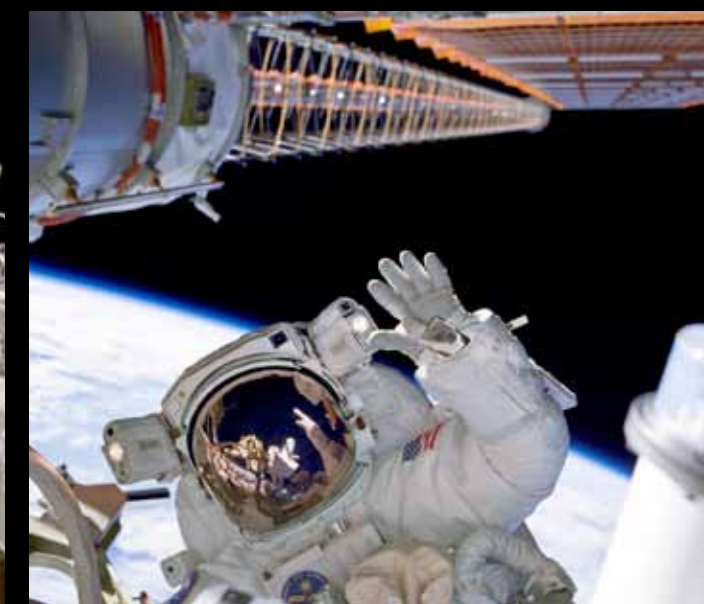
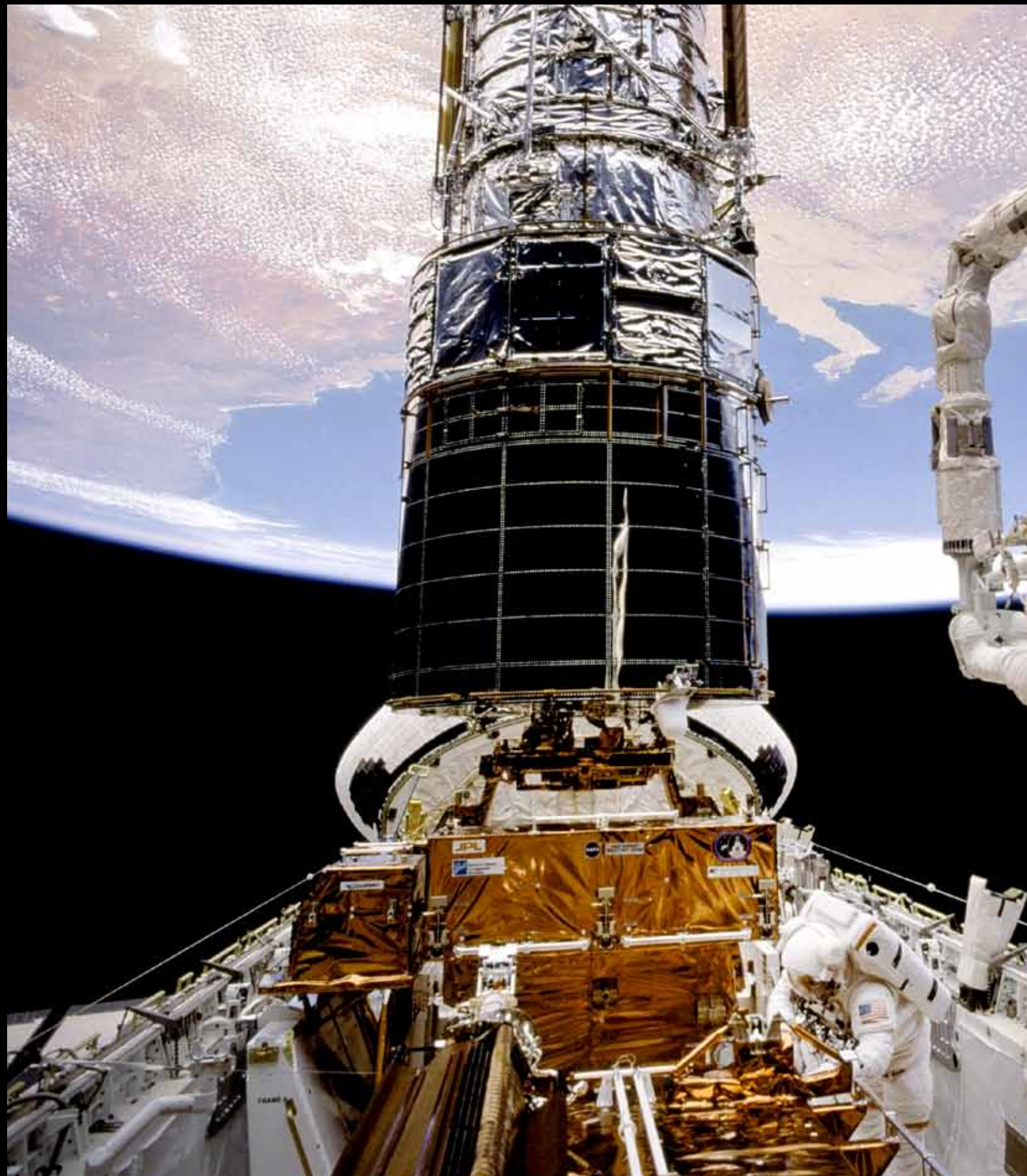
Mike Burghardt, manager of spacecraft development for Commercial Crew, said Boeing’s design would accommodate up to seven crew members and would be compatible with a variety of expendable launch vehicles. Depending on NASA’s final schedule, it could be ready to fly as early as 2015.

“In some respects, it’s similar to the Apollo command and service modules, which were built by Boeing legacy company North American Rockwell,” Burghardt said. “But unlike Apollo, the Commercial

**PHOTOS: (Right)** *Atlantis* is docked to the International Space Station on a mission in May 2010 to install a Russian-built compartment named *Rassvet*, or Dawn, which is visible in the shuttle’s cargo bay.

**(Insets, from left)** The payload bay, vertical stabilizer and other features of *Atlantis* are captured in this photo taken by a crew member during the STS-129 mission to the space station in November 2009; a drawing of Boeing’s Commercial Crew vehicle that could one day carry astronauts to the space station. NASA





**PHOTOS: (Far left)** Astronaut Story Musgrave stands on the end of *Endeavour's* robotic arm during the first servicing mission for the Hubble Space Telescope in 1993. Fellow astronaut Jeffrey Hoffman is inside the shuttle's payload bay.

**(Insets, from top)** *Endeavour*, with its cargo bay doors open and robotic arm partially extended, is shown above Earth during the STS-126 mission in November 2008, bringing supplies and equipment to the International Space Station; mission specialist Carlos Noriega waves during a spacewalk on STS-97, the sixth construction flight to the International Space Station, installing a truss segment that included a solar array. NASA

Crew spacecraft will be reusable and carry a larger crew.”

In addition to working on Commercial Crew, Burghardt was part of the space shuttle team from 1987 until early 2010. He has mixed feelings about the shuttle program winding down. The shuttle was a magnificent vehicle with enormous capabilities, Burghardt said, but he's excited about moving forward in developing new spacecraft.

Development of the space shuttle began in July 1972 when the National Aeronautics and Space Administration (NASA) awarded North American Rockwell the contract to build the first shuttle orbiter. Rockwell (which became Rockwell International the following year) went on to build the rest of the shuttle fleet. The shuttle program became part of The Boeing Company in 1996 when Boeing purchased Rockwell International's aerospace and defense assets.

Construction of the space station was the shuttle's most important accomplishment, but it completed many other complex assignments over the past three decades. Hubble, which the shuttle deployed on orbit in 1990, was a particularly delicate payload. The shuttle has also launched interplanetary space probes, such as the Galileo spacecraft, which was attached to a Boeing-developed Inertial Upper Stage with enough fuel to propel it on a gravity-assisted six-year trip to Jupiter.

The shuttle, in addition to launching satellites from its cargo bay, captured and repaired existing satellites that had failed in orbit. In some cases,

satellites were captured and returned to Earth for more complex repairs. The shuttle also hosted a number of scientific experiments that required zero gravity or other conditions unique to space.

After winning the contract, Rockwell named George Jeffs, who had been heading the Apollo program, to become the first space shuttle program manager. Jeffs, who later became president of Space and Energy Operations, said Rockwell's performance, processes and relationships with NASA, which had been developed during Apollo, played an important part in Rockwell winning the shuttle contract.

"It was a major challenge to develop the space shuttle, which is truly a marvel of hypersonic flight," Jeffs said. "The orbiter was the first vehicle of its type, and there were major aerodynamic, flight control, thermodynamic and software problems to solve. It was a hill to climb; there's no question about that."

Jeffs, who ran the shuttle program from 1972 to 1982, said the shuttle was the first spacecraft that could "land with dignity," like an aircraft on a runway. During the Gemini program, Jeffs led the development of a paraglider system to bring that spacecraft down on land, but NASA opted for splashing down in the ocean. For Jeffs, the shuttle was a dream come true.

Bob Minor, who headed the shuttle program from 1988 to 1997, started work on the program in 1970 when he was a manager on the original team that prepared Rockwell's bid for the shuttle contract. Once the contract was won, he went to work on the design.

"Designing the shuttle was a daunting task, but it is a privilege that we all shared," Minor said. "We had a bunch of engineers who were just fantastic. And NASA was a great customer."

Minor, who retired in 1999, said the challenge of developing the shuttle's thermal protection system was "a sporty one," something that had never been done before. The system of tiles that protect the shuttle during the high heat of re-entry was particularly difficult. He said the team spent many late evenings and weekends developing procedures for installing the tiles and ensuring that they would remain in place during liftoff.

And the shuttle's unique role—a space vehicle that could

**PHOTOS:** (Near right) A technician checks the thermal protection tiles on the bottom left wing of *Atlantis* after it returned from a mission. (Insets) The first shuttle, *Enterprise*, which was not designed to fly into space, is shown at the plant in Palmdale, Calif. Employees built the forward fuselage, crew module and aft fuselage of the shuttles at Downey, Calif. NASA



***"Working at Downey, Calif., during the space shuttle program was an experience. Huge paint flakes on the inside walls looked like they could fall off and hurt you—most memorably above a door to the outside used daily by hundreds of employees. The roof leaked, so we had varying processes for catching and diverting water when it rained. But we didn't complain because we sensed that magic was happening, and we knew the whole world was watching us."***

*— Anita Gale, Associate Technical Fellow and senior project engineer, Space Shuttle Payload & Cargo Integration*

land like a glider—required diverse technical talent involving both aviation and space expertise.

The company's Downey, Calif., facility served as the design center for the space shuttle program. It also manufactured major sections of the shuttle.

Downey employees manufactured the forward fuselage, the crew module and the aft fuselage. These sections were transported to the company's nearby Palmdale, Calif., plant, where Palmdale employees assembled the orbiters.

"It was fantastic, and things were busy every day," said Dwight Woolhouse, recalling his early days at Downey. He joined the shuttle program in 1972 and currently serves as program manager for Orbiter Design. "Drawings were being released as the design of the shuttle matured and various tests were going on. There was always something new."

The first orbiter to be completed, *Enterprise*, rolled out at Palmdale on Sept. 17, 1976. *Enterprise* was not designed to be flown in space. Instead, it was used in approach and landing tests to confirm that the orbiter could fly in Earth's atmosphere and land like a glider. These tests were conducted at the Dryden Flight Research Center at Edwards Air Force Base in 1977. *Enterprise* was attached to the top of a specially modified Boeing 747 and released over Edwards. The tests were a success.

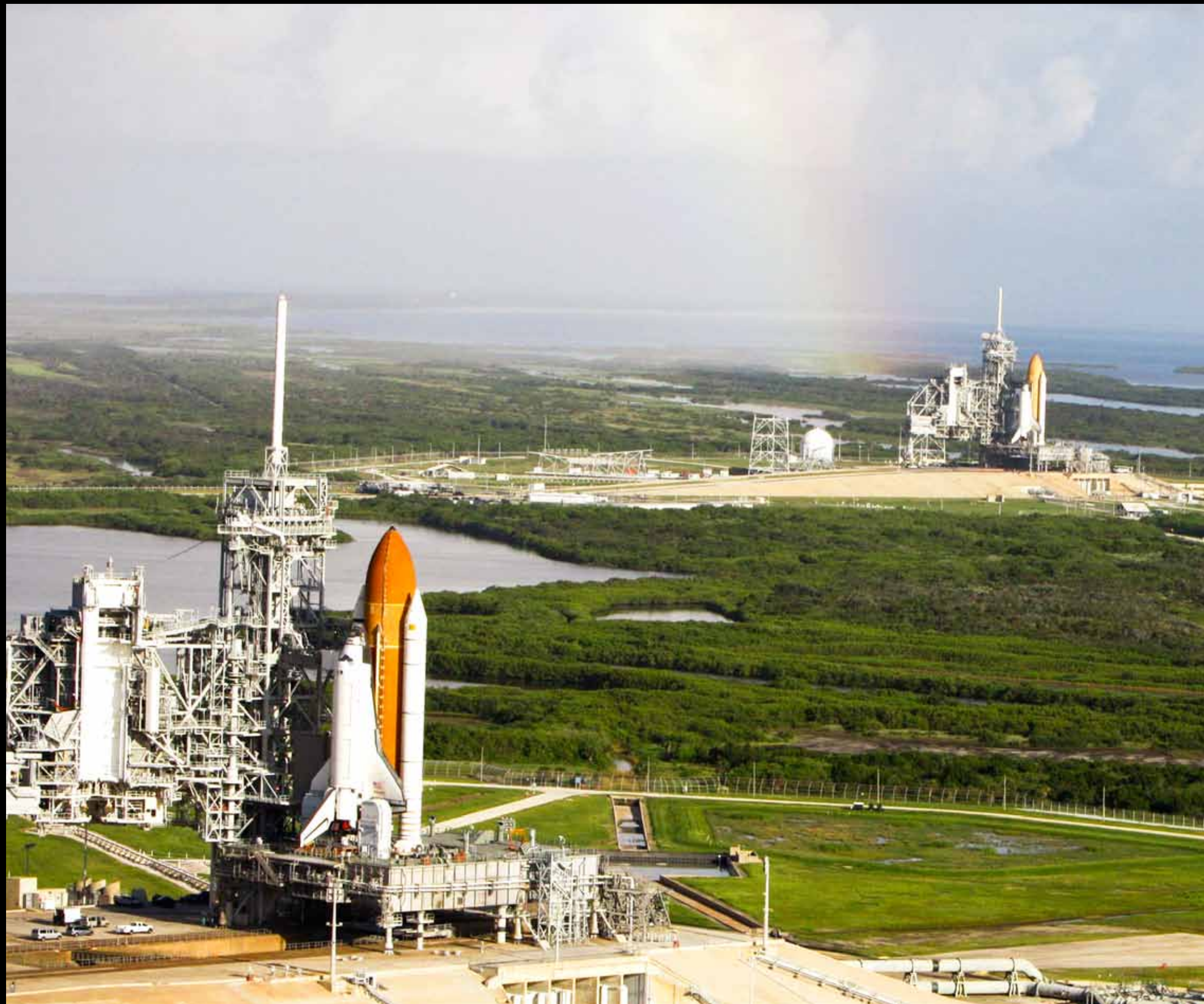
"To me, the real heroes of the space shuttle program are the people who validated the *Enterprise*," said Bob Kahl, shuttle program manager at Palmdale. "That first separation flight—with the *Enterprise* lifting off the back of a 747, then gliding down—had to be the most incredible thing I've ever witnessed. The astronauts who performed those tasks

***"This mating of two large vehicles was highly unusual, and there were concerns over how well it would work. But the first flight went perfectly. After we gained confidence, we began our approach and landing tests."***

— Bob Minor, former vice president and general manager, Boeing Space Systems division, talking about the crucial test flights of *Enterprise* after it was carried aloft on the back of a modified 747

**PHOTO:** *Enterprise* is released from the back of a modified 747 and subsequently glided to a landing at Edwards Air Force Base, Calif., Feb. 18, 1977. This critical early test flight proved the shuttle could fly and land like a glider. NASA





played a vital role in getting us to where we are today.”

Other orbiters followed: *Columbia* made its first flight in 1981, *Challenger* in 1983, *Discovery* in 1984, *Atlantis* in 1985 and *Endeavour* in 1992.

During the history of the program, dignitaries, celebrities and public officials visited the Downey and Palmdale facilities. In 1982, some 6,000 employees welcomed President Ronald Reagan as he toured the plant and delivered a speech on America’s future in space. In 1983, England’s Queen Elizabeth II and Prince Philip visited the Downey plant. Jeffs led the queen on a tour and helped her to “fly” the space shuttle simulator.

The shuttle program enjoyed great success during the more than 130 missions. But there was also tragedy. On Jan. 28, 1986, *Challenger* exploded 73 seconds after liftoff, killing its seven-member crew. On Feb. 1, 2003, *Columbia*’s seven astronauts died when the vehicle broke up over Texas during re-entry. In both cases, lengthy investigations took place and a number of program changes were made before the fleet returned to flight.

Mulholland recalled that when *Columbia* was lost, Boeing employees didn’t hesitate to step forward to offer assistance.

“It wasn’t 24 hours after the accident,” he said, “that we were getting calls from throughout Boeing offering expertise that proved to be vital, not only in reconstructing what had happened, but in making the changes necessary to return to flight.”

Mulholland said his two greatest memories of leading the shuttle program center around having a remarkable, history-making product, and working with an exceptionally talented, dedicated and loyal team.

“We’ve been very lucky, because there are very few programs that have spanned the amount of time that this one has,” Mulholland said. “And it’s just amazing how many people have stuck with it—in some cases, for their entire careers.” ■

*william.j.seil@boeing.com*

**PHOTO:** It was a rare sight—two space shuttles on launch pads at Kennedy Space Center at the same time. But it happened in 2009 when *Atlantis*, foreground, waited on Launch Pad 39A for the final mission to service the Hubble Space Telescope, while *Endeavour* was on Launch Pad B. Once *Atlantis* lifted off, on May 11, *Endeavour* was moved to Pad 39A for the STS-126 mission to the space station. The two orbiters would subsequently make the final flights of the space shuttle program in 2011. NASA

# FROM MICE TO **SPACE PROBES**

Space shuttles hauled a variety of cargo into orbit—and sometimes back to Earth

Over the past three decades, the space shuttles hauled a variety of items into space—from small science experiments to major sections of the International Space Station.

“The space shuttle was designed primarily to operate like a truck, taking cargo into orbit and, in some cases, bringing things back,” said former shuttle astronaut Steve Oswald. “But I don’t think any of us imagined the full versatility of this vehicle and the kinds of payloads it would carry over the program’s 30-year history.”

Oswald, now chief operating officer, Information Solutions, Boeing Network & Space Systems, piloted two missions aboard *Discovery* in 1992 and 1993 and commanded *Endeavour* in March 1995. All three missions were primarily scientific. Oswald served as vice president and program manager of the Boeing Space Shuttle Program from 2001 to 2007.

Anita Gale, Associate Technical Fellow and senior project engineer, Space Shuttle Payload & Cargo Integration, said major shuttle payloads have included interplanetary probes, like the Galileo spacecraft in 1989, and a number of satellites.

One particularly challenging mission occurred in 1984, when *Discovery* retrieved two communications satellites that had been launched to the wrong orbits. Another major project was the deployment of the Hubble Space Telescope.

“Hubble was a huge, amazing integration process,” Gale said. “We worked for years to accommodate that one.”

The shuttle also was used to carry classified military payloads.

Don Stieler is the payload mechanical engineering lead on the final space shuttle mission, STS-135, *Atlantis*, which is scheduled for July. He has supported shuttle flights at Kennedy Space Center since the beginning, missing only the first space shuttle launch in 1981.

“There’s a lot of emotion involved in preparing for this final flight,” Stieler said. “Everybody is keeping their focus. We want this mission to be the best.”

Mike Kinslow, a Boeing payloads flow manager at Kennedy Space Center, said payloads are generally loaded on the launch pad to allow late changes when needed. Some of the most challenging, he said, were orbiting observatories, which have sensitive sensors and optics, and interplanetary probes, which have their own fuel supply.

Scientific experiments contain living specimens, such as plants, insects or rodents. They have to be changed out if a mission is scrubbed.

“One team I supported had been working on a module for 20 years,” Kinslow said. “It’s been exciting to work with each of these teams and to be part of such an important program.” ■

**PHOTOS: (Near right)** Boeing employees Kevin Jackson, left, and Donald Stieler at Kennedy Space Center prepare a container packed with supplies that *Atlantis* will carry to the International Space Station on what will be the final flight of a space shuttle, a mission tentatively scheduled for July. **(Middle)** They are joined by Kevin Koby, shown at bottom of photo. **(Far right)** Stieler, from left, Koby and Jackson. BOB FERGUSON/BOEING



# From *Enterprise* to *Atlantis*

Key dates in the U.S. shuttle program

**Sept. 15, 1969** – The Space Task Group, an advisory panel appointed by the president, recommends the development of a new space transportation capability.

**Jan. 5, 1972** – President Richard Nixon approves the development of the space shuttle.

**Sept. 17, 1976** – *Enterprise*, a test vehicle not designed for orbital flight, is rolled out at Rockwell's Palmdale, Calif., facility.

**April 12, 1981** – *Columbia* becomes the first space shuttle to orbit Earth.

**Feb. 7, 1984** – Bruce McCandless becomes the first person to walk in space without being fastened to a spacecraft. He flies 320 feet (100 meters) away from the orbiter *Challenger*.

**Aug. 30, 1984** – *Discovery* is launched on its first mission.

**Oct. 3, 1985** – *Atlantis* makes its first flight.

**Sept. 29, 1988** – Following major design modifications, the space shuttle program returns to flight with the launch of *Discovery*.

**Oct. 18, 1989** – *Atlantis* is launched, carrying the Galileo/Jupiter Spacecraft and attached Inertial Upper Stage. Galileo is sent on a six-year trip to Jupiter.

**April 5, 1991** – *Atlantis* is launched. On the third day of the mission it deploys the Gamma Ray Observatory, the first observatory to be deployed by a shuttle since the Hubble Space Telescope.

**Aug. 17, 1993** – NASA selects Boeing as the prime contractor for the International Space Station.

**June 29, 1995** – *Atlantis* docks with the Russian space station Mir, marking the first time since the 1975 Apollo-Soyuz project that the two nations docked in space.

**Aug. 13, 1998** – Boeing announces that its Reusable Space Systems operations, including the space shuttle program, would vacate facilities in Downey, Calif. Manufacturing would move from Downey to Palmdale, Calif., and the remainder of its activities would relocate to Huntington Beach, Calif.

**Dec. 4, 1998** – The space shuttle fleet's role in the construction of the International Space Station begins. *Endeavour* carries the Boeing-built Unity Node into orbit and mates it with the Zarya Control Module, which had been launched atop a Russian Proton rocket on Nov. 20.

**May 19, 2000** – The launch of *Atlantis* introduces a host of enhancements, including an adaptation of the glass cockpit system used in the Boeing 777.

**Feb. 7, 2001** – The crew of *Atlantis* installs the Boeing-built Destiny Laboratory Module at the International Space Station. Destiny provides a shirt-sleeve environment for research projects in life sciences, microgravity sciences, Earth science and space science.

**Feb. 1, 2003** – *Columbia* and its seven astronauts are lost when the vehicle breaks up over Texas during re-entry.

**Jan. 14, 2004** – President George W. Bush announces a new Vision for Space Exploration. The shuttle's chief purpose will be to help finish the assembly of the International Space Station. Afterward, the shuttle fleet will be retired.

**July 26, 2005** – The space shuttle program returns to flight with the launch of *Discovery*.

**March 11, 2008** – *Endeavour* begins a 16-day flight, the longest shuttle mission to the International Space Station to date.

**May 11, 2009** – The crew of *Atlantis* launches on the final servicing mission to the Hubble Space Telescope.

**Feb. 24, 2011** – *Discovery* is launched on its final mission.

**May 16, 2011** – *Endeavour* is launched on its final mission.

*Atlantis* will be the final shuttle flight, tentatively scheduled for July 2011.

**July 20, 1969** – Neil Armstrong and Edwin Aldrin land the Apollo 11 lunar module on the surface of the moon.

**July 26, 1972** – North American Rockwell, a Boeing legacy company, wins the contract to build the first space shuttle orbiter. (North American Rockwell became Rockwell International the following year.)

**Feb. 18, 1977** – *Enterprise* is flown atop a modified Boeing 747 for the first time. The tests prove the orbiter can fly in the atmosphere and land like a glider.

**April 4, 1983** – *Challenger* is launched on its first mission.

**Nov. 8, 1984** – *Discovery* is launched on a mission that includes the retrieval of two malfunctioning communications satellites: Palapa B2 and Westar VI. Astronauts deposit the satellites in the shuttle's payload bay.

**Jan. 28, 1986** – *Challenger* explodes 73 seconds after liftoff; its seven-member crew is lost.

**May 4, 1989** – *Atlantis* is launched on a mission that deploys the Magellan/Venus radar mapper spacecraft and attached Inertial Upper Stage, or IUS. The Boeing-developed IUS sends the spacecraft on a trajectory to Venus.

**April 25, 1990** – The Hubble Space Telescope is deployed from Space Shuttle *Discovery*.

**May 7, 1992** – *Endeavour* is flown for the first time. It includes a number of technical improvements, including the first use of a drag chute during landing.

**Dec. 2, 1993** – *Endeavour* is launched on an 11-day mission to upgrade and service the Hubble Space Telescope, correcting a serious optical problem. It is one of the most challenging and complex manned space missions ever attempted.

**Dec. 6, 1996** – Boeing purchases the aerospace and defense units of Rockwell International, which includes the space shuttle program.

**Oct. 29, 1998** – John Glenn—who, in 1962, became the first American to orbit Earth—is launched into space on Space Shuttle *Discovery*. At age 77, he becomes the oldest person to fly in space.

**July 23, 1999** – *Columbia* is launched, carrying the Chandra X-Ray Observatory. Chandra becomes the third observatory to be deployed by a shuttle, beginning with the Hubble Space Telescope in 1990.



# The right stuff

Space shuttle fleet opened new frontiers for space exploration

## Enterprise

It was not designed to go into space—but the shuttle orbiter missions that followed would not have been possible without *Enterprise*. On Feb. 18, 1977, *Enterprise* was carried on the back of a 747 and released above Edwards Air Force Base, Calif., gliding to a safe landing. The test proved the shuttle could fly and land like a glider. It was supposed to be named “Constitution.” But through a write-in campaign, viewers of the science fiction TV show “Star Trek” urged NASA to name it after the starship *Enterprise*.

## Columbia

The first shuttle to be launched into space, on April 12, 1981, *Columbia* was named after a small sailing vessel that in 1792 explored the mouth of the Columbia River in the Pacific Northwest. *Columbia* was the first of the shuttles to carry Spacelab—a medical research lab that allowed astronauts to conduct experiments in the shuttle cargo hold—in orbit, in June 1991. *Columbia* was destroyed and its crew of seven died when the shuttle broke up while re-entering Earth’s atmosphere for landing on Feb. 1, 2003.

## Challenger

The second orbiter to join the shuttle fleet, *Challenger* first flew into space on April 4, 1983. Named after a British naval research vessel that sailed the Atlantic and Pacific oceans in the 1870s, *Challenger* was the first shuttle to be launched and to land at night, during the STS-8 mission. And it was the first to land at Kennedy Space Center rather than the California desert. On Jan. 28, 1986, *Challenger* was destroyed and its crew of seven lost when a booster rocket failed and caused an explosion 73 seconds after launch.

## Discovery

The third orbiter to join the fleet, *Discovery* was launched on its first mission on Aug. 30, 1984. One of its most notable missions came in April 1990 when *Discovery* deployed into orbit the Hubble Space Telescope. *Discovery* completed more missions than any other shuttle. It was named after two famous ships—one used by Henry Hudson 1610–1611 to search for a northwest passage between the Pacific and Atlantic oceans, and the other by British explorer James Cook in the 1770s when he discovered the Hawaiian Islands.

## Atlantis

It lifted off from Kennedy Space Center on its first trip into space on Oct. 3, 1985. In addition to delivering vital components to the International Space Station, *Atlantis* has been used to launch a number of important spacecraft, including planetary probes Magellan and Galileo. It also flew the first of seven shuttle missions that docked with the Russian space station Mir. *Atlantis* will make the final flight of the space shuttle program, a mission tentatively scheduled for July.

## Endeavour

The fifth and last of the shuttles, *Endeavour* was built as a replacement for the *Challenger* after it was lost in an accident. *Endeavour*’s first space flight came on May 7, 1992. Among its many missions, *Endeavour* was used to begin construction of the International Space Station, when it carried the Boeing-built Unity node into orbit in December 1998. The node was attached by astronauts to a Russian-built control module.

SOURCE: NASA; PHOTOS: NASA

# ‘It was the most exciting thing that’s happened in my lifetime’

Those who worked on the shuttle program share their memories of an incredible adventure

**“Watching a shuttle launch is an emotional, powerful experience ... You feel it in your gut. It’s just a beautiful thing to see. And what makes it even more exciting is knowing that you’ve had a role in making it happen.”**

– Gloria Castellanos, product and service quality manager, Boeing Space Shuttle Program

**“I was always amazed at how well the space shuttle handled. In space, as we advanced into more complex missions, we came to realize what a neat flying machine the orbiter really was.”**

– Steve Oswald, former space shuttle astronaut and currently chief operating officer, Information Solutions, Boeing Network & Space Systems

**“When we were building the orbiters—even the Enterprise—the astronauts who had been assigned by NASA lived at Palmdale. They were here every day and knew the employees by name. It was as though they were part of the workforce.”**

– Bob Kahl, program manager, Boeing Space Shuttle Program, Palmdale, Calif.

**“I joined the space shuttle program in 1972. When I look back at those four decades, I have to say, what a stroke of luck it was for me to have a career working in a program that, in my opinion, was the best, most exciting thing that’s happened in my lifetime.”**

– Dwight Woolhouse, program manager, Orbiter Design

**“When I was growing up, because my father was a shuttle astronaut, we lived and breathed the space shuttle program and the whole idea of space exploration. I hadn’t planned on working in the program. I joined Boeing in 1999 and the opportunity opened up several years after I was hired. I’m particularly glad that I’m here with the program as it comes to an end.”**

– Darien Onizuka-Morgan, contract administrator, Boeing Space Shuttle Program, and daughter of astronaut Ellison Onizuka, who died when Challenger exploded in 1986.

**“Queen Elizabeth visited the Downey plant in 1983 and I had the honor of giving her a tour. She was a space buff. She told me she had seen every Apollo launch on television. When she tried flying the shuttle simulator, she didn’t do too badly. While she didn’t land the spacecraft, she did get it down on the glide path.”**

– George Jeffs, former president, Rockwell Space and Energy Operations

**“I will always remember my time with the program with great pride and satisfaction. And it was such a miraculous experience for me, having come to this country as a foreign student from Bangladesh and ending up in this amazing program.”**

– Shireen Rahman, Guidance, Navigation & Control Analyst, Boeing Space Shuttle Program

PHOTO: *Discovery* is launched on the STS-131 mission in April 2010. NASA

***“We’re just on the cusp of revolutionizing human access to space. What I’m really excited about is the next 50 years and what we’re going to be able to achieve. I believe it’s going to be as remarkable as the achievements of the past 50 years.”***

*– John Mulholland, vice president and program manager, Boeing Space Shuttle Program*



**PHOTO:** With its landing gear down, *Endeavour* approaches the runway at Kennedy Space Center for a night landing in February 2010, after a 14-day mission to the International Space Station. The shuttle program is coming to an end, and *Endeavour* made its final flight on May 16, 2011. NASA

# Joined at the HIP

The world's leading international leisure travel company enjoys a special relationship with Boeing—and its jets

By Marcy Woodhull

**“Having the 787 in our fleet will allow us to expand our offerings to more exotic locations, given the 787’s range, capacity and scale. It will take our customers where they want to go.”**

— Chris Browne, managing director of Thomson Airways



When Europeans consider a holiday, whether it's a luxury cruise, Antarctic expedition or anything in between, chances are they turn to TUI Travel or one of its subsidiaries for a comprehensive package that not only takes them where they want to go but also takes care of all their needs when they get there.

Operating in 180 countries and headquartered in the United Kingdom, TUI Travel is the world's leading international leisure travel company, offering every sort of vacation a consumer can dream up.

Heavily concentrated in Europe, TUI Travel serves more than 30 million customers a year in 27 key markets. The only leisure travel firm listed on the

London Stock Exchange, the company employs 49,000 people.

The TUI Travel umbrella includes seven airlines, all of which operate Boeing airplanes. In the U.K., one its largest markets, the company operates under the Thomson brand, offering every facet of a vacation, including air transportation on Thomson Airways.

“A traveler's holiday starts the moment they step on the airplane,” said Chris Browne, managing director of Thomson Airways, the U.K.'s largest charter airline and third-largest airline.

Fundamental to the company's continued success, Browne said, is its relationship with Boeing.

“We are joined at the hip,” she said.

Thomson Airways operates 737 and 757 Boeing airplanes and has ordered the 787 Dreamliner.

“Having the 787 in our fleet will allow us to expand our offerings to more exotic locations, given the 787's range, capacity and scale,” Browne said. “It will take our customers where they want to go.”

TUI Travel was an early customer for the 787 and has 13 Dreamliners on order for four of its seven airlines: Thomson Airways; TUIfly Nordic, representing the Scandinavian region; Jetairfly, based in Belgium; and Arkefly in the Netherlands. Other airlines operated by TUI Travel are Corsairfly in France; Jet4you.com in Morocco; and TUIfly Germany.

Browne said she has been a fan of the

787 since it was on the drawing board and that it offers unrivaled qualities and will be less expensive to operate. “With higher fuel costs, it is even more compelling to have the 787,” she said.

TUI Travel also is launch customer for Boeing's GoldCare maintenance, repair and support services program for the 787.

“We've put our faith and trust in Boeing with the 787 and that Boeing is the best one to look after the aircraft,” Browne said.

TUI Travel's standards for customer service, value and responsibility push its suppliers, including Boeing, to perform at their highest levels, according to Debra Santos, Boeing sales director for the group.

“TUI Travel values are all about the customer,” Santos said. “They deliver the best

possible product to their customers, and our products are a means to do this. They work extremely hard, always try to find a way and have very high expectations. If we didn't always deliver the highest-quality products, they would not work with us.”

That working-together collaborative spirit, Santos said, results in benefits for both companies.

“They made a commitment with the 787 and have stayed with us,” Santos said of TUI Travel. “They look to Boeing for lifelong products and services with the 787 and GoldCare.”

Successful partnerships mean understanding each other's business, Browne added.

“Boeing understands our business

better than anyone else,” she said. “We're a holiday carrier, not a scheduled carrier, and that is a big difference.” ■

[marcy.woodhull@boeing.com](mailto:marcy.woodhull@boeing.com)

**PHOTO ILLUSTRATION:** A 787 Dreamliner, shown here in Thomson livery.

BOEING

**PHOTO:** Chris Browne, managing director of Thomson Airways, at last year's Farnborough International Airshow in the United Kingdom. STEVE DUNLOP

# Lend

## A HELPING HAND

New technologies make work easier and safer for Boeing employees

By Marcy Woodhull



**S**anding paint from the underside of an airplane wing with hand-held tools can be hard on the shoulders.

It requires a person to stand underneath the wing and reach overhead in an awkward posture. Hand-held sanders vibrate, strain wrists and require a finger grip that causes fatigue.

Boeing's John Amell set out to change this.

"We worked with employees and management and tried several different things over the past 10 years, such as robots, remote control, custom handles and sanders on a stick," said Amell, an Associate Technical Fellow and ergonomist with Boeing Research & Technology.

so can cleaning Boeing facilities.

Ask Chandelle Osborne, who knows too well how stooping, reaching and standing all day can take a toll.

"When cleaning restrooms, we had a cart for all our cleaning products and equipment. And it required a lot of bending, kneeling, reaching and lifting heavy trash bags," said Osborne, team leader for Factory Services, part of Shared Services Northwest Facilities.

But today, a machine developed by a creator of no-touch cleaning systems is replacing those carts.

"It's like a pressure washer, and is far more effective than manual cleaning," Osborne said.

The machine not only cuts the work

said Melissa Findlay, a Boeing Research & Technology ergonomist who leads implementation of this software. "We are able to mitigate risk and prevent injuries by focusing our resources on solutions in the areas at highest risk for injury."

For those Boeing wing sanders, the solution was a mechanical arm that allows them to maneuver objects as if they were weightless.

Working with the company that created the tool, Amell and his Boeing colleagues developed an attachment for the mechanical arm to hold the sander. It's easy to grip, and employees can maintain better posture when sanding with far less shoulder stress and exposure to vibration. Boeing Research & Technology is looking at opportunities to



**"We are supporting technology development, embedding ergonomics and safety analysis into the design of products, and using ergonomic tools and processes."**

— Missy Brost, senior manager for Boeing Research & Technology

"Nothing worked adequately."

But Amell and his colleagues eventually found a solution by working with a company that manufactures a "zero gravity" mechanical arm.

It's just one of many examples of how Boeing is improving workplace safety.

New technologies are being developed and introduced in various areas of the enterprise as part of Safety Now, a companywide effort to reduce workplace injury rates over five years, said Amy May, Safety and Health senior manager in Environment, Health and Safety.

"We want to keep people safe to enjoy their work and enjoy their time away from work," explained Missy Brost, senior manager for Boeing Research & Technology. "We are supporting technology development, embedding ergonomics and safety analysis into the design of products, and using ergonomic tools and processes."

Just as sanding an airplane wing can be demanding and hard on the body,

time by a third but also reduces risk factors associated with repetitive motion, awkward movements, bending and lifting heavy buckets. It also reduces costs for chemicals and equipment.

"And, most important, it does an amazing job," Osborne said. "We've had so many compliments on the cleanliness of the restrooms, and we've had more than 175 days without a lost workday due to injury. The staff goes home feeling more energetic and not aching after a day at work."

While new technology is making it easier for employees to do their jobs, it's also important to have a better understanding of where technology can help make a difference.

At the Everett, Wash., site, for example, advanced data-visualization software is being used to understand the relationship between injury data and production data.

"This is allowing us to understand where we have the highest risk of injury,"

replicate this solution throughout Boeing manufacturing processes.

"We're always working," Amell said, "on better tools and design processes to help people do their jobs without injuries." ■

marcy.woodhull@boeing.com

To learn more about Boeing efforts to improve workplace safety and find improvement resources, visit the Safety Now website at <http://safetynow.web.boeing.com> on the Boeing intranet.

**PHOTOS: (From far left)** In Everett, Wash., Chuck Olinzock uses a mechanical "arm" for safer sanding of a 787. GAIL HANUSA/BOEING In Renton, Wash., Factory Services' Chandelle Osborne uses an indoor pressure washer that reduces the risk of ergonomic injury. MARIAN LOCKHART/BOEING In Everett, Wash., 747 Final Assembly mechanic Scott DeLack uses a rivet squeezer that is ergonomically safer than a rivet gun. ED TURNER/BOEING

# SHOW time!

Preparing Boeing aircraft for the Paris Air Show is like making a movie—with a cast of many

By Terri Christofferson and photos by Jim Anderson



**“We are only a part of a larger team that works together to make things happen.”**

— Jasper Corleis, a lead Flight Test Operations engineer and test director



**PHOTOS: (Left)** Jasper Corleis, left, and Willie Matthewson are part of the team that creates and executes plans to get Boeing products to key public gatherings such as this month's Paris Air Show. **(Above)** Rodney Tong, from left, Mike Rosenzweig, Becki Neel, Janice Denard and Charles Hartshorne inspect safety gear that's put on aircraft appearing at air shows.

Like pilots who fly the aircraft, this Boeing team has its own “checklist” that must be completed in order to make the show.

As in the Paris Air Show, granddaddy of all the international air shows, which takes place this month in France.

Long before air-show visitors have the opportunity to get up close to the aircraft, a team of Boeing Test & Evaluation employees has crafted detailed plans to get Boeing products to the show—and get them on display safely. It is part of the broad range of duties the test organization handles to provide high-quality services that support the company's many business programs.

The test director has a master plan for the entire trip, similar to a script for

a movie.

Jasper Corleis, a lead Flight Test Operations engineer and test director, described the effort as a well-orchestrated event that involves dozens of people behind the scenes.

Boeing is working to bring several products for static display during this year's air show.

From fuel loading to the route taken, from weather checks to security on the ground, Flight Test Operations is responsible for coordinating all the necessary pieces.

“We are only a part of a larger team that works together to make things happen—and sometimes our contribution seems small, compared with the total effort required,” Corleis said. “We have

the airport technology experts who tell us the surface strength of runways, weight and balance experts who tell us how much the airplane weighs, and countless others who make this possible.”

Prior to departure, Flight Test Operations will conduct a readiness review, which includes the pilots as well as representatives from Dispatch, Weights & Balance, Test Integration, Ground Operations, Quality, Manufacturing, International Security Activity, Global Trade Control, Test Program Management, and Instrumentation.

The safety of the people and the airplane come first; mission objectives, second.

Safety preparations for the show include checking that the site has adequate facilities and required tools, and ensuring that security personnel, both local and

from Boeing, are in place. Coordination also is needed with catering and scheduling to make sure the flight team is fed and well-rested before and during the flight.

The planning heavily involves Ground Operations, which has two main responsibilities: managing test airplane configuration and serving as onboard cabin safety representatives during testing and general operations. A two-day class is mandatory for Ground Operations and focuses on aviation safety, from treating minor injuries to evacuation exercises.

During the training, the team responds to simulated emergencies—fire, power outages and injuries.

In a swimming pool, fully clothed participants learn techniques for floating, keeping warm in a group and supporting

someone who is injured. From a 737 cabin simulator, they practice using emergency equipment such as fire extinguishers, smoke hoods and fire axes. Flight physiology—how the body acts and reacts at altitude—is included.

At the air show, while Marketing will decide what areas of the airplane should be on display or accessible, it is up to Ground Operations to make necessary arrangements to protect people, the airplane and the environment around the airplane.

Ground Operations determines areas of the airplane that are safe for general access, taking into consideration hot or cold surfaces, test installations, and more. The team makes sure everyone is safe moving around the cabin, especially when casual observers are present.

Hatches, which allow access to the lower part of the airplane, are secured during static display and sharp edges are shielded to prevent injuries.

Willie Matthewson, a lead Ground Operations engineer, is a cabin safety expert for Experimental Flight Test programs.

“In a public venue,” he said, “the airplane can be touched, toured or have restricted access. We've got to be ready for all the options.” ■

[terri.l.christofferson@boeing.com](mailto:terri.l.christofferson@boeing.com)

# SAFE

haven

Creating the right culture is key to reducing workplace injuries

By Marcy Woodhull



“Management and employees are working together, sharing the value of safety, listening to each other and caring about each other’s welfare.”

– David Renteria, production flight-test technical inspector, Boeing Defense, Space & Security

**PHOTOS:** (Far left) David Renteria, left, and Oscar Mortera inspect a machine that loads seats into the AH-64D Apache Longbow attack helicopter. BOB FERGUSON/BOEING (Left) In Auburn, Wash., machined-parts finisher Geri Marquardt uses a tool with a fitting that swivels as her wrist moves, so she can comfortably guide the tool around small parts used on Boeing commercial jetliners. JESSICA OYANAGI/BOEING

An Apache Longbow team in Mesa, Ariz., was on a mission: how to install 140-pound (64-kilogram) seats in the AH-64D model while reducing the risk of potential injury or pain from back, shoulder, arm and leg strain ... or worse.

But when a seat-loading machine arrived at the Apache helicopter production site in Mesa, it didn’t solve the problem.

Not only was it “tremendously heavy,” but the machine lacked sufficient clearance for the helicopter’s rotor blades, said David Renteria, a production flight-test technical inspector.

“We tried to make it work,” he said, “but ended up not using it and it just sat there collecting dust.”

Challenged to make the seat loader usable, Renteria and his Employee Involvement team worked with Oscar Mortera of Boeing Research & Technology and conducted an ergonomic assessment and analysis.

“With each person’s input, we sent our improvements to have the seat loader right-sized,” Renteria said.

The result: “Any individual of any size can now load a seat into the helicopter,” he said.

The experience not only made life better for the seat-loading team, but it went a long way in changing the organization’s culture.

“We learned the value of early employee engagement,” Renteria said. “Management and employees are working together, sharing the value of safety, listening to each other and caring about each other’s welfare.”

Open communication, leaders who set the example and employee recognition are critical to a culture that promotes safety, according to Stephen Boone, leader of Environment, Health and Safety at the Boeing site in San Antonio, which provides maintenance and modification services for large aircraft.

“Safety and well-being are about more than ergonomics and processes,” Boone said. “They are based in people and their relationships with one another. ... The motivation extends far beyond injuries. We truly care about employees not only staying safe and injury-free at work but also that they enjoy their personal time without pain or injury.”

There are many examples around Boeing where the culture has significantly contributed to improved workplace safety.

When Geri Marquardt arrived at the Commercial Airplanes Fabrication site in Auburn, Wash., in 1997 as a machined-parts finisher, employees were expected to work with the tools they were given.

“The company emphasized safety, but there wasn’t much focus on ergonomics,” she said.

Then Boeing began offering Move Smart training, which includes techniques to help prevent injuries and trauma both on and off the job.

“We began paying more attention to body mechanics and how our work environment is set up,” said Marquardt, who works in the Auburn Machining and Emergent Operations organization. “We adjusted our work-in-process shelves for

each person, to minimize reaching and bending instead of having all of them at the same height.”

The local Moonshine Shop (a Lean+ activity that focuses on how processes can be improved) helped employees come up with a hydraulic system for adjusting worktables to an employee’s height.

Workers began asking for more ergonomic tools and the company responded.

“I used to use air-powered tools with fittings that didn’t flex,” Marquardt said. “Now they move with my wrist.”

Marquardt said management’s commitment to safety and well-being has created an environment in the Auburn Machining and Emergent Operations organization where employees are engaged, their input is valued, and they are listened to by management.

“Our processes are constantly being revisited and tweaked,” she said. “People understand and believe that our organization and Boeing care about our health and well-being.” ■

*marcy.woodhull@boeing.com*

To learn more about Boeing efforts to improve workplace safety and to find improvement resources, visit the Safety Now website at <http://safetynow.web.boeing.com> on the Boeing intranet.

# GLOBAL BOEING

*Boeing's international strategy focuses on mutually beneficial partnerships*

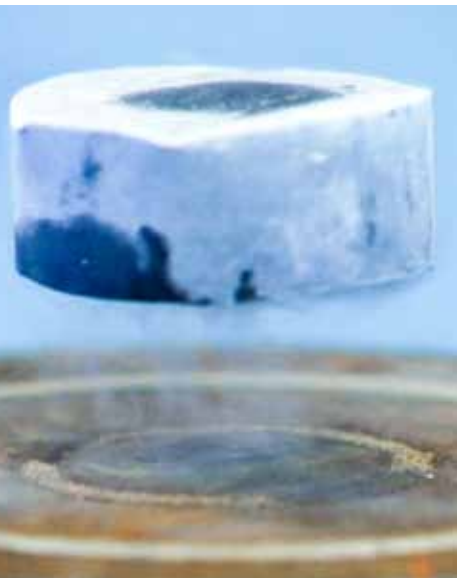
*By Bill Seil*

**A**round the globe, Boeing is developing partnerships that benefit its customers, business partners and local economies. In return, the company is strengthened by growing sales and tapping the best technologies the world has to offer.

In 2010, sales outside the United States accounted for 41 percent of Boeing's revenue. That number is expected to increase significantly over the next few years.

More than 80 percent of the Boeing Commercial Airplanes' backlog is for jetliners ordered by non-U.S. customers. And international sales are rapidly increasing as a portion of Boeing Defense, Space & Security's total revenue.

Shep Hill, president, Boeing International, said Boeing has long focused on



providing the best and most innovative products and services at affordable prices. The company also has worked to meet the specific needs of individual customers and regions.

"Doing business in today's global economy also means differentiating ourselves in terms of the partnerships we establish within each country," he said. "That includes local suppliers, universities, research talent and charitable institutions. It's all about having a meaningful, mutually beneficial presence."

Boeing's international strategy supports the strategies of its business units and aligns with the expectations and aspirations of the countries in which it operates. In doing so, the company values diversity and is sensitive to local laws and customs.



Boeing is enhancing its presence internationally by hiring local talent and deploying U.S. employees at key locations around the world. More than 8,500 of Boeing's 164,000 employees work outside the United States.

This strategy also involves establishing and strengthening research and development partnerships worldwide, as international markets fuel R&D growth.

The amount spent worldwide on research and development grew from \$790 billion in 2002 to \$1.15 trillion in 2007, according to the United Nations Educational, Scientific and Cultural Organization. This is the most recent figure available and reflects increased activity in Asia.

Boeing's expansive portfolio of global research and development partnerships



includes entities from 35 nations for research in diverse areas including biofuels, manufacturing processes, structures and robotics.

"Because there's more than \$1 trillion of investment in technology development around the world, it's in Boeing's interest to develop mutually beneficial research partnerships with institutions across the globe to leverage those investments for the sake of our customers," said John Tracy, Boeing chief technology officer and senior vice president, Engineering, Operations & Technology.

"These partnerships provide us access to advanced technologies that can improve our products and make us more competitive," he added. "And by working with these institutions and establishing international research



*"By working with these institutions and establishing international research sites, we demonstrate that we're committed to building a long-term presence in important markets."*

*– John Tracy, Boeing chief technology officer and senior vice president, Engineering, Operations & Technology*

sites, we demonstrate that we're committed to building a long-term presence in important markets."

In addition to providing the best, most advanced products, the company is continually increasing its ability to provide outstanding customer service, quickly and effectively, throughout the world. ■

*william.j.seil@boeing.com*

*Read more about the global strategies for Boeing Commercial Airplanes and Defense, Space & Security on the following pages.*

**PHOTOS:** Boeing's partnerships around the world are fueling growth in research and development and making the company more competitive. (Clockwise, from top left) Composites research in the United Kingdom; new manufacturing methods in Spain; the 787 Dreamliner; research in unmanned airborne systems; aerodynamic testing using wind tunnels; and superconducting applications. BOEING

# RAISING THE BAR

*Expanding its international business is critical to the growth of Boeing Defense, Space & Security*

*By Paul Lewis*

Turn the clock back to 2005 and international sales generated little more than 7 percent of overall revenue for Boeing's defense business. Sales at that time were overwhelmingly driven by domestic demand, while countries such as Brazil, India or Qatar were faraway places few knew little about.

Fast-forward to today and the picture is very different.

Output of Boeing-built fighters, airlifters and surveillance systems is increasingly reliant on orders from the Middle East, South Asia and the Far East. Look no further than the delivery ramps in St. Louis, Long Beach, Calif., or Boeing Field in Seattle, where there are F-15Ks destined for South Korea, C-17s for the United Arab Emirates or 737 Airborne Early Warning & Control aircraft for Australia, to name just a few of Boeing's lengthening list of international clientele.

Export sales last year accounted for almost 18 percent of Boeing Defense, Space & Security's nearly \$31.9 billion in revenue, and this impressive rate of growth is not expected to level off anytime soon.

Dennis Muilenburg, president and CEO of Boeing Defense, Space & Security, has flagged international growth as one of five strategic objectives for Accelerated Change, and in January he raised the bar for export sales to 25 percent or more of overall revenue by 2013.

The task of finding this new business falls to the International Business Development organization in Defense, Space & Security.

Mark Kronenberg, vice president of International Business Development, said the challenge is not just reaching 25 percent or more but sustaining that level of activity over the long haul.

"It is clear, simply selling more of what we now produce will by itself not get us there," he said. "We need to think differently about the markets we serve, how we as a business are organized and the partnerships we forge. We must strive to be a truly global company if we're going to be successful in this endeavor."

International Business Development has mapped out a comprehensive strategy for sustained growth. It calls for the development of people globally, building and integrating a Defense, Space & Security presence in local markets, creating new opportunities through alliances and partnerships, developing



**PHOTOS: (Top)** One of two Qatar Emiri Air Force C-17 Globemaster III airlifters Boeing has delivered to the Middle Eastern country. **BOEING (Above)** Keith Ternes, left, and Steven Stoverink work on the aft end of an F-15 fighter in St. Louis. **BOB FERGUSON/BOEING (Above right)** An artist's concept of a P-8I with India livery. **BOEING (Right)** Korea Aerospace Industries produces major assemblies for the AH-64 Apache. **KOREA AEROSPACE INDUSTRIES**

"We must strive to be a truly global company if we're going to be successful."

*— Mark Kronenberg, vice president of International Business Development*



a more robust portfolio of exportable products and, perhaps the most critical of all for ensuring repeat business, enhancing customer satisfaction.

A first step has been the reorganization of International Business Development and a significant strengthening of the team.

Critical, too, is staying closely aligned with Boeing Commercial Airplanes, which today draws 80 percent of its business from overseas, and harnessing the reach of Boeing International and its worldwide network of country presidents.

"We must work across the enterprise as a single team if we are to succeed," Kronenberg said.

Leveraging "One Boeing" has proved especially important in those markets new to Defense, Space & Security but where Commercial Airplanes has enjoyed a long-standing presence. India is a good example. Until recently India was inaccessible to Defense, Space & Security and other U.S. defense companies, whereas Commercial Airplanes has enjoyed a 70-year history.

When in 2005 the doors to Delhi began to open to U.S. contractors, Defense, Space & Security quickly established a presence, thanks to Commercial Airplanes. Success came in 2009 with an Indian Navy order for eight P-8I maritime patrol aircraft.

To be successful in today's highly competitive international environment, it is increasingly important to partner with both local companies and other global players. Teaming brings access to markets that might otherwise be off-limits, potential new technology and talent, as well as opportunities for industrial participation.

Over the past 30 years, Boeing has successfully implemented programs in nearly 40 countries, delivering benefits of more than \$41 billion on time or ahead of schedule.

Such programs go by many names: industrial cooperation, industrial benefits and offsets, to name a few. Whichever the name, the overall goal is the same: to fuel economic flow-back to a customer country as a result of that government's procurement of goods and services from Boeing.

Boeing currently has 53 active industrial programs worth more than \$17 billion in 22 countries, representing more than 15 Boeing products. In the next five years, Defense, Space & Security alone is looking at another \$34 billion in potential industrial programs as it pursues expanded international sales.

"We draw on the breadth and depth of Boeing to tailor each program to meet the specific requirements of the customer and to address the industrial development objectives of that country," said Gwen Kopsie, director of the organization working across Boeing businesses to shape how and whom the company works with globally to best support the growth strategy for Defense, Space & Security.

Boeing already boasts a chain of long-standing alliances around the world with well-known players.

Japanese industry over the years has built a large number of Boeing programs under license such as the F-15J, CH-47J Chinook and Apache. Korea Aerospace Industries produces major assemblies for the AH-64 Apache, A-10 and F-15 programs, while Boeing recently teamed with Italy's Finmeccanica to win a major training contract in Singapore.

The emergence of new growth markets brings with it potential new partners.

"The Middle East is now one of BDS' fastest-growing markets fueled by demand to recapitalize fighter aircraft,



“Being able to nurture and harness local know-how and creativity through partnering is key to broadening BDS offerings and sustaining international growth in the long term.”

– Gwen Kopsie, director of International Strategic Partnerships, Boeing Defense, Space & Security



airlift, rotorcraft and airborne surveillance capabilities,” said Paul Oliver, International Business Development regional director for the Middle East and Africa.

Today, Defense, Space & Security has some 2,800 employees based in 30 countries, the largest number of which work for Boeing Defence UK and Boeing Defence Australia. (See March 2011 *Frontiers*, Page 38.)

Boeing’s global footprint continues to grow and broaden into other markets.

In the past 12 months, Defense, Space & Security established a presence in Qatar and added to its worldwide network of analysis modeling, simulation and experimentation centers with a new facility in Bengaluru, India.

“Being able to nurture and harness local know-how and creativity through partnering is key to broadening BDS offerings and sustaining international growth in the long term,” Kopsie said.

The acquisition of companies such as Insitu, Narus, Argon ST and Tapestry Solutions has also served to provide greater depth and breadth. With these additions has come access to new and previously untapped international markets like cybersecurity, logistics command and control, and networked and unmanned systems.

For Defense, Space & Security to sustain 25 percent plus of international revenue over the long haul, customer satisfaction is an indispensable component.

“The impression we make, the trust we build and the promises we keep,” Kronenberg said, “are the most important elements to ensuring our customers and industry partners keep coming back to BDS.” ■

*paul.j.lewis2@boeing.com*

# FORWARD DEPLOYMENT

*Close relationships with global customers is key to Commercial Airplanes’ success*

**By Bill Seil**



**PHOTOS: (Above, from left)** New fuel-efficient and quieter GENx engines boost performance of the 747-8 Intercontinental on long-haul international routes. GAIL HANUSA/BOEING The Boeing Commercial Airplanes Operations Center answers urgent service requests around-the-clock from airlines operating more than 12,000 Boeing airplanes globally. MARIAN LOCKHART/BOEING

**T**he more than 12,000 Boeing commercial jetliners in service around the world bring people together and help shape the global economy.

Boeing Commercial Airplanes has a global network that supports the maintenance and operation of these airplanes. It also has sales representatives based throughout the world who help airline customers to expand and upgrade their fleets and make their operations run more efficiently. In addition, the company has a worldwide network that works with its international suppliers.

Boeing’s Current Market Outlook report, which forecasts growth over the next 20 years, projects that the number of commercial airplanes worldwide will nearly double by 2029—increasing from 18,890 airplanes to 36,300. During that period, airplane deliveries for fleet growth and replacement of aging airplanes is expected to total around 30,900. In addition, Boeing forecasts that over the next 20 years the world’s airlines will need nearly a half-million new pilots and nearly 600,000 new technicians to support that growth.

Marlin Dailey, senior vice president, Sales & Marketing, said Commercial Airplanes is advancing a strategy of forward deployment—basing sales representatives near airline customers around the world. This has already taken place in Europe, the Middle East, Australia, China and throughout Asia. It helps the sales teams to get an even closer understanding of customers’ complex needs, build deeper relationships, and leverage company resources to more effectively support customers’ business objectives.

“We tend to be most effective in areas where we live with our customers,” Dailey said. “The more time we spend with our customers and become embedded with their businesses, the more successful we’re likely to be.”

The company is also making a greater effort to add local hires to its sales force around the world.

While the international market is currently outperforming U.S. sales, Dailey noted that markets fluctuate and U.S. sales will spring back.

“Today’s market is very dynamic and can change very quickly,” Dailey said. “So our ability to be nimble and be responsive will be increasingly important as we move forward.”

Supporting the existing worldwide fleet of Boeing jetliners is a complex task. A division of Boeing Commercial Airplanes,

**PHOTOS: (Above, from left)** A Peace Eye Airborne Early Warning & Control aircraft for the Republic of Korea is shown in flight. CHAD SLATTERY Under license, Japanese industry builds the CH-47J Chinook. JAPAN AIR SELF-DEFENSE FORCE

“Strong relationships with our suppliers are just as important as our relationships with our customers.”

— Ray Conner, vice president and general manager, Supply Chain Management & Operations

Commercial Aviation Services, or CAS, offers a portfolio of products, services and support aimed at helping airlines maximize the lifetime value of their fleets and operations, providing them with a competitive edge in their markets.

“We have aligned our business with the way our customers operate,” said Lou Mancini, senior vice president, Commercial Aviation Services. “Services that are vital to airline operations are located as close to the customer as possible.”

He pointed out that Commercial Aviation Services has eight spare-part distribution locations in the United States, Europe, the Middle East and Asia. They are staffed around-the-clock with an inventory of roughly 500,000 different types of parts.

In addition to day-to-day services, Commercial Aviation Services has pioneered digital tools to help speed airplane troubleshooting and manage the entire maintenance process of an airplane. One such tool, Airplane Health Management, is an integrated family of information products and services that collects, monitors and analyzes real-time airplane performance data, helping identify future maintenance needs.

Commercial Aviation Services oversees subsidiaries Aviall, AeroInfo, Continental DataGraphics, Inventory Locator Service and Jeppesen, as well as joint ventures Aviation Partners Boeing and Boeing Shanghai Aviation Services.

Assembly of Boeing jetliners is supported by an extensive global supply chain. At an enterprise level, Boeing leads 5,400 direct supplier manufacturing sites worldwide. Supplier management representatives are based both regionally and on-site to ensure integration and alignment throughout the Commercial Airplanes’ value stream.

“The success of our supply chain is directly related to the success of Boeing,” said Ray Conner, vice president and general manager, Supply Chain Management & Operations. “Strong relationships with our suppliers are just as important as our relationships with our customers. We are all linked, so it’s really in our best interest to work seamlessly together to execute the same plan and strategy.” ■

[william.j.seil@boeing.com](mailto:william.j.seil@boeing.com)



**PHOTOS: (Above, from left)** An employee of Boeing subsidiary Aviall uses a bar code scanner to verify a shipment to one of the company’s 40 global stocking locations. **AVIALL** A Boeing Shanghai technician works on an aircraft engine at the maintenance, repair and overhaul facility. **BOEING**

# The Sky's the limit

The story of the Next-Generation 737 is one of continuous improvement

By Dawsalee Griffin and photos by Bob Ferguson



At first glance, the airplane landing at Boeing Field in Seattle doesn’t look any different from other 737-800s. But this airplane, fully fueled, can fly farther than any 737 before it, thanks to the engine and aerodynamic improvements it is testing.

The most visible sign that this airplane is different is the new, more teardrop-shaped anti-collision light. The streamlined light is more aerodynamic than the familiar pillbox shape—something that looks like it belongs on a police cruiser.

Other improvements on the test airplane include alterations to the airframe to reduce drag, as well as enhancements to the CFM engines.

“This performance improvement package gives operators about 2 percent better

**PHOTO:** Sameoun Van, 737 mechanic, assembles a cockpit. Recent 737 flight-deck improvements include enhanced displays and upgraded Electronic Flight Bag capability.



**PHOTO:** Winglets, introduced in 2002, were one of the first performance improvements added to the Next-Generation 737. Now, about 95 percent of the planes at the Renton, Wash., factory have winglets.

performance than the current models,” said John Hamilton, 737 chief project engineer.

That might not sound like much, but it can add up to \$120,000 a year in fuel savings, depending on the cost of fuel, according to Hamilton. And 2 percent equals 470 tons (430 metric tons) less carbon emitted per airplane annually.

These are just the latest improvements Boeing has made to its Next-Generation 737 family.

Hamilton calls it “investing in the product.”

That investment began shortly after the Next-Generation 737s went into service. Over the past 12 years innovations have ranged from performance improvements to a new interior to improved reliability and enhanced navigation aids—always pushing the boundaries to find ways to increase value for the customer.

The result, including the performance improvement package, is about a 7 percent performance improvement, making the Next-Generation family more efficient than its rivals, according to Boeing. And the company is already at work defining the next round of improvements.

“We’ve improved the product every year since the Next-Generation went into service,” Hamilton said.

One of the first innovations came in 2002 when Boeing offered what’s now the 737’s most recognizable feature—fuel-saving Blended Winglets.

About 95 percent of all the 737s being built in the Renton, Wash., factory now sport Blended Winglets, which can improve fuel consumption by 3.5 to 4 percent.

In 2008, Boeing offered carbon brakes for its 737s.

“We looked at using carbon brakes when we were originally designing the Next-Generation 737,” Hamilton said, “but the technology wasn’t where we needed it to be.”

When the carbon technology did catch up, the 737 engineers were ready to take advantage of it. The 737’s optional carbon brakes offer a 700-pound (320-kilogram) weight savings, equal to three passengers or 0.4 percent less fuel consumption. Carbon brakes also last three times longer than steel brakes.

Other improvements developed since 2000 include the ability of the 737 to land at high-altitude airports or those with runways less than 5,000 feet (1,520 meters) long.

But performance improvements are only one area where Boeing is continuing to enhance its 737s.

Passenger comfort is as important to Boeing as it is to the airlines, Hamilton said. “We share the results of our studies and get feedback from our customers about improvements they’d like to see.”

Some of those are included in the new 737 Boeing Sky Interior, with its open, roomy look.

Boeing also continues to make improvements and cut operational costs in other ways, working with airlines and regulators to improve efficiencies in the air traffic system, and improving product quality on its already-efficient production line.

And the company is working with airlines on navigation procedures that enable pilots to make more direct approaches, especially on landing—saving time and fuel.

“In line with our legacy of continuously improving our products,” Hamilton said, “we’ll keep figuring out how we want to make our product even better going forward.” ■

*dawsalee.griffin@boeing.com*

**EYE AND THE NEEDLE**

The giant radar vessel developed by Boeing for the U.S. Missile Defense Agency is a dramatic sight against the nighttime Seattle skyline and its famous Space Needle tower as the converted oil platform navigated last month to a local shipyard for maintenance. The Sea-based X-band Radar, or SBX, towers more than 280 feet (85 meters), from its keel to the top of the huge white radome. Designed to identify, track and assess the flight characteristics of ballistic missile threats, the sensor is a key component of the Ground-based Midcourse Defense system for which Boeing is prime contractor. Boeing won a \$27.1 million contract to perform SBX maintenance and upgrades. PHOTO: DAVE HUTSELL/BOEING

