BOEING

100

Frontiers

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COVER ILLUSTRATION BY CHRISTOPHER HANKS

The cover for this special issue marking Boeing's centennial has a strong focus on the future and the exciting possibilities for Boeing employees in the company's second century, from extended space travel to hypersonic transports. It also pays tribute to the employees and innovations of Boeing's first 100 years, which shaped the world and how we live.

MAGAZINE DESIGN BY KATIE ALLEN

We are the founders of our future

As Boeing begins its second century, it's our turn to look ahead and make our mark

Boeing, Douglas, Kindelberger, McDonnell. We know these names and many others because of the incredible legacy left by our heritage founders. With rugged determination and a passion for the new science of flight, these pioneers couldn't fully imagine what the future held for the company—and the industry—they would help build.

Throughout the past 100 years, Boeing has connected and protected people and nations, explored our world and the vastness of space, and inspired dreamers and doers alike through our products and services, our innovation, and the skill and talent of generations of employees. We took the world from seaplanes to space planes, across new frontiers and beyond. Few companies have achieved as much.

Today, at the start of our second century, it's our turn to imagine what comes next and bring it to life. In another 100 years, we might make daily trips to space, fly across the globe in less than an hour or receive unlimited clean power from solar satellites. Our potential for achievement is as great as it was for our founders, and our goals must be just as bold, visionary and inspiring. We will be the aerospace leader and an enduring global industrial champion only by continuing to ask as much of ourselves as they asked of themselves.

Together, we are the founders of our future. Each of us is a humble steward of a great legacy, and each of us has the potential to build on that legacy and make a positive, lasting impact on our second century, especially when we work together as a "One Boeing" team, with the utmost integrity and excellence.

I give sincere thanks to our past and present employees, customers, communities and everyone who is a part of—or an enthusiast of—Boeing and aerospace. We could not have reached our centennial without you, and you are the reason we will succeed in our next 100 years. Boeing's legacy—and its incredibly bright future—belongs to all of us. ●

1916

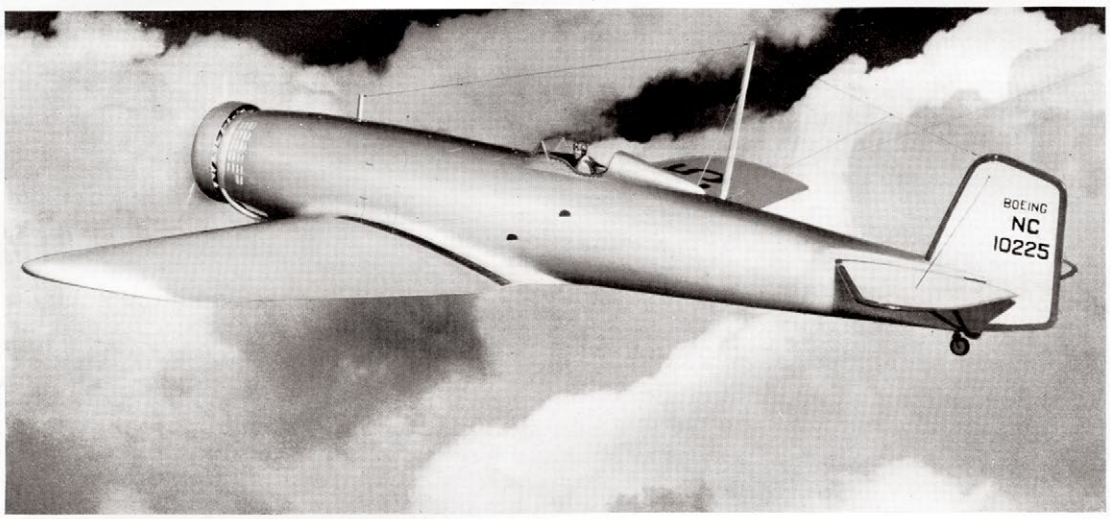
B & W seaplane

William Boeing begins final assembly of the B & W seaplane in his Seattle hangar. The Boeing Airplane Co. is incorporated.

Boeing Monomail

With its single cantilever wing and smooth all-metal construction, the Monomail made traditional biplane design a thing of the past. The airplane configuration was a trendsetter with retractable landing gear, a streamlined fuselage and a cowl-covered engine, the first time many of these advances had been brought together. The aircraft first flew on May 6, 1930, and began delivering mail and passengers a year later. The structural and aerodynamic features of the Monomail were duplicated on Boeing's first bomber, the B-9, and the world's first modern airliner, the Boeing Model 247. ●

2300 POUNDS PAYLOAD
. . . . . *at 160 m.p.h.**



Built experimentally for United Air Lines, this 1929 Hornet-powered Monomail proved as advanced in performance as it was in design. Not only was it the first successful "smooth skin" commercial model ever built; it was also the first to employ retractable landing gear — another instance of Boeing production years ahead of its time . . . Boeing Airplane Company, Seattle, Subsidiary of United Aircraft & Transport Corporation.

BOEING

*BOEING has *always* built *to-morrow's* airplanes TO-DAY

Ad No. T-932 — Full Page
August, 1932, Trade Papers
McCANN-ERICKSON, Inc., Seattle

Happy Birthday, Boeing!

PHOTOGRAPHY AND ILLUSTRATIONS BY
BOEING | NASA | SHUTTERSTOCK

Happy Birthday to all the Boeing folks on your centennial. You can be proud of the significant contributions that Boeing has made over the decades to our nation's aviation and space excellence throughout the world.

GENE CERNAN

Former NASA astronaut (top far right) and commander of Apollo XVII; he was the last person to walk on the moon (bottom)

1919

B-1 seaplane

The B-1 seaplane is the first Boeing-designed commercial airplane.

My very best memories of childhood are sitting in the jump seat of the Boeing airplanes that my dad flew—the 727 and the 747—and flying to exotic places. The name “Boeing” still conjures freedom, escape, adventure and romance. In fact, the beautiful print I see across from my desk every day is Mike Machat’s “Gold Cup Roll” of Tex Johnston rolling the Boeing 367 Dash 80 passenger jet over Seattle’s Lake Washington. You could say I’m a Boeing girl. If it’s not Boeing, I’m not going!

PATTY WAGSTAFF

World and U.S. aerobatic champion and member of the National Aviation Hall of Fame

Over more than half a century of my involvement in aviation—the opportunity to fly as passenger and pilot on so many Boeing aircraft, live in its hometown, get to know so many of its people and leaders, and later write and report on Boeing subjects—the synonymous nature of Boeing with the concept of quality has never been eroded. Happy Birthday, Big B! Your wonderfully engineered products have literally been the wings beneath so much of my life.

JOHN J. NANCE

Author, ABC-TV aviation analyst and former airline pilot

I was very impressed with the B-25. It was a wonderful airplane to fly. It was very maneuverable at low altitudes and faster than most of the bombers at that time. We were in the air for 13 hours, from carrier to bombing mission. It was a long way for a medium bomber to fly. We had to haul gasoline on board. I flew just that one mission in it before I was sent to North Africa, where I flew the Martin B-26 Marauder. Personally, I’ve flown in nearly all of the Boeing commercial jets, starting with the 707. Keep up the good work.

DAVID THATCHER

Flight engineer and gunner on one of 16 B-25 bombers, made by Boeing heritage company North American Aviation (a B-25 is pictured above), that took off from an aircraft carrier to make the Doolittle Raid on Japan in April 1942; his plane was later featured in the book and movie *Thirty Seconds Over Tokyo*

1920

The Davis Douglas Co. is founded.

Boeing has been a significant part of my life, beginning with my engineering studies at the University of Washington in Seattle. My first aerospace company employment was with Boeing Computer Services, and later I worked on the space shuttle design and construction—followed by the special opportunity to fly on the shuttle a few times under the Boeing operations contract. Boeing has continued its mission into space with the International Space Station and the CST-100 Starliner. I expect that Boeing will continue to be an aerospace leader in the 21st century. The one word that best captures my definition of Boeing is "excellence." Happy Birthday!

BONNIE DUNBAR

Former NASA astronaut who logged more than 50 days in space as a mission specialist and payload commander on board five space shuttle flights; after retiring from NASA she served as president and CEO of the Museum of Flight in Seattle and is now a research professor in aerospace engineering at Texas A&M University

It's been tremendous, starting with the first transaction I did on a Boeing aircraft, which was in 1977, when I bought our first new 737-200. That began a long history of acquiring new aircraft from Boeing that resulted in well over a thousand airplanes that I've purchased. There's been a long association and Boeing has made a major imprint on my career and my footprint in the aircraft airline industry. There's definitely a long-term partnership of working together and coming up with commercial aircraft solutions for the global aircraft industry. Fly high for the next 100 years.

STEVEN UDVAR-HAZY

Chairman and chief executive officer for Air Lease Corp., a pioneer in the airplane leasing business; he previously founded and led International Lease Finance Corp., one of the world's largest airplane leasing companies

I also flew the B-25, P-39 and P-47, but the P-51 was it! It was a good airplane and my favorite for the mission. The P-51 was very good for escorting bombers. It had auxiliary tanks that were carried under each wing. You had to switch to outside tanks when you needed to refuel … So Boeing is 100 years old? Happy Birthday. We are almost the same age.

WASHINGTON DUBOIS ROSS

Now 97, one of the original Tuskegee Airmen, African American U.S. military pilots who gained fame during WWII for escorting B-17s on missions over Germany. The tails of their P-51s were painted red (illustrated below) and they became known as the "Red Tails"

1921

Cloudster passenger biplane
The first aircraft wholly designed and built by Douglas, the Cloudster also is the first airplane to lift a useful load exceeding its own weight.

At Continental, my last official job as CEO was to order 20 787s. I was a Boeing guy, obviously. I believed in guys like T Wilson, Frank Shrontz, Phil Condit, Ron Woodard and Dean Thornton—those were my heroes. Every one of them, in some way, added to the success of Boeing. Those were the kind of people that Boeing produced. If they said they were going to do something, they did it. My bet is that 100 years from now we will still be talking about Boeing and it will still be leading the industry, whether it's with a rocket ship or whatever aircraft they have by then. I would never bet against Boeing.

GORDON BETHUNE

Former chairman and chief executive officer of Continental Airlines and former vice president and general manager for Boeing's 737 and 757 programs

I grew up in the world of Boeing aviation. My father flew over 35,000 hours for the commercial airlines. I loved flying, especially the takeoffs and landings, and being in the airports and seeing all the planes and people traveling from city to city. I knew my father flew Boeing aircraft and I thought all planes were Boeing. It was always the name I associated with the energy and excitement that I loved so much about flying! Boeing, here's to the next 100 years of taking the magic of flight above and beyond.

U.S. NAVY CAPT. CORRIE MAYS

F/A-18E/F Super Hornet weapons systems officer and events coordinator for the Blue Angels (above), the Navy's precision aerobatic team that flies F/A-18 Hornets

1923

DWC transport
The Douglas World Cruiser is the first airplane to fly around the world.

PW-9 Model 15 fighter
The Model 15 is the first successful fighter aircraft designed by Boeing. It has a steel-frame fuselage combined with wooden spars and ribs.

Aerospace is not an industry of sprints. It is an industry of long, grueling marathons. And—like a marathon—commercial aviation is a tough and competitive business. Despite the pain, that competition makes us all better and serves the entire industry as well. There is no doubt that Boeing defined commercial aviation in the 20th century and won the large majority of those marathons. So to all my friends at Boeing: Happy 100th Birthday!

JOHN LEAHY
Chief operating officer, Customers, Airbus

Boeing is one of the great companies of all time. Over a century, it has advanced commercial aviation and globalization to levels unimaginable at its founding. Boeing's remarkable and reliable aircraft have been a major part of FedEx's growth and success, and we appreciate the strong support we've received from Boeing for decades. Happy 100th to the entire Boeing team, from your friends at FedEx!

FRED SMITH
FedEx chairman, president and chief executive officer

I started working with Boeing back in 1992, when I arrived in Houston to attend training in preparation for the joint U.S.-Russia space shuttle mission. My two flights (one of which is pictured at right) gave me an opportunity to experience the company and see its power and technical capability. In 1998, when I retired from the cosmonaut corps, Boeing invited me to work in its Moscow office as a part of the international space shuttle team. I met a lot of good people in the company and learned many new and interesting things. Today, with the greatest pleasure, I would like to congratulate Boeing and its employees on the company's 100th anniversary. I wish you prosperity in the new century.

VLADIMIR TITOV
Russian cosmonaut, who with a fellow cosmonaut were the first humans to spend an entire year in space, logging 365 consecutive days in Russia's Mir space station in 1987–88; Titov later was awarded the title "Hero of the Soviet Union"

1927

Model 40A mail and passenger airplane
The Boeing Model 40A two-passenger mail plane is Boeing's first production commercial airplane—it launches Bill Boeing's airline, Boeing Air Transport.

Over the years, I have watched and learned from the great history of Boeing, following with enthusiasm its many technological achievements that have made flying safer and more efficient. I have no doubt that the next 100 years at Boeing will bring even more innovation, spawning new career paths that we cannot even define today.

DEAN KAMEN

Inventor of the Segway and founder of FIRST, a national nonprofit organization that encourages young people to study science, technology, engineering and math through events such as the FIRST Robotics competition (above)

It's no exaggeration to say that Boeing and its people have helped change the world throughout the 100-year history of the company. Obviously it has had a huge impact on me and my businesses. Virgin Atlantic took its first flight from London to Newark on a Boeing 747 when the company took the risk of leasing us our first plane. Our partnership has only become stronger over the past 32 years. We're looking forward to continuing to innovate with Boeing for many years to come.

SIR RICHARD BRANSON

Founder of the Virgin Group

You build great airplanes, you build strong airplanes and you build airplanes that pilots love to fly.

BRUCE DICKINSON

Pilot and lead singer of the rock band Iron Maiden; the group's current world tour is supported by a 747 (above)

Douglas DC-1, DC-2 and DC-3

Following the pioneering Boeing Model 247, Douglas Aircraft used this series of airliners to change how people flew. They quickly made other airplanes obsolete. Just one DC-1 was produced and it flew for the first time on July 1, 1933. (It was subsequently purchased by Howard Hughes.) With each succeeding year, the Boeing heritage company introduced a new model. The DC-2 made its first flight on May 11, 1934. The bigger and faster Douglas Sleeper Transport, soon to be known as the DC-3, made its first flight on Dec. 17, 1935. By 1939, more than 80 percent of U.S. domestic scheduled airline service was handled by the DC-2 and DC-3. The DC-3, and its military derivatives, became one of history's best-known airplanes. ●

NORTH AMERICA: American Airlines Inc. . . . Braniff Airways . . . Canadian Colonial Airways, Inc. . . . Eastern Air Lines . . . Northwest Airlines, Inc. . . . Pan American Airways . . . T. W. A. . . . United Air Lines . . . Western Air Express . . . Wilmington-Catalina Airline . . . Cia Mexicana de Aviacion, S. A., Mexico . . . **SOUTH AMERICA:** Pan American Airways . . . Pan American Grace Airways . . . **AUSTRALIA:** Airlines of Australia . . . Australian National Airways . . . **EUROPE:** A. B. Aerotransport, Sweden . . . Air France, France . . . Avio Linee Italiane, Italy . . . C. L. S., Czechoslovakia . . . K. L. M., Netherlands . . . L. A. P. E., Spain . . . L. A. R. E. S., Roumania . . . LOT, Poland . . . S. A. B. E. N. A., Belgium . . . Swissair, Switzerland . . . **ORIENT:** China National Aviation Corporation . . . K. N. I. L. M. in Netherlands Indies . . . Japan AirTransport

Flying Fortresses...

GREATER THAN EVER

● Pioneering is a BOEING tradition, and long before national defense assumed the vital importance it has today, BOEING developed that mighty monarch of defense — the 4-engine Flying Fortress, pride of the U. S. Army Air Corps. The basic idea of the Flying Fortress was so far in advance of its time that today's version of this airplane — the world's fastest long-range bomber — is the fifth production series — each model an improvement on its predecessor. Now being delivered to the Air Corps is a fleet of B-17D Flying Fortresses; now under construction in the expanding BOEING plant is a fleet of B-17E models — incorporating still greater advancements. Thus, at a time of national emergency, BOEING, with unequalled experience in building 4-engine aircraft, is ready with the proven designs, background, equipment, and craftsmen to speed the delivery of new Flying Fortresses — America's standard bearers of leadership in military aircraft.

Boeing has always built tomorrow's airplanes today!

Boeing AIRCRAFT COMPANY
SEATTLE, WASHINGTON

B-17 Flying Fortress

This four-engine heavy bomber became a symbol of U.S. military might in World War II, dropping more bombs (640,000 tons, or 580,600 metric tons) than any other American aircraft. It was hailed for its ability from high altitude to inflict damage—and survive it. The B-17 made its first flight on July 28, 1935. More than 12,700 eventually would be built. At one point during the war, Boeing's Plant 2 in Seattle rolled out 15 of the bombers in 24 hours. They were also built at Douglas and Lockheed-Vega factories. Gen. Carl Spaatz, American air commander during WWII, summed up the bomber's combat importance in this manner: "Without the B-17, we may have lost the war." ●

Far out

STORY BY DAN RALEY
ILLUSTRATIONS BY CHRISTOPHER HANKS

One hundred years from now, a family makes vacation plans and takes the kids someplace they've never been before—Earth.

The travelers lock up their residence on their orbiting space colony, built by Boeing, and climb aboard a hypersonic commercial airplane, also produced by Boeing, and fly off to see what those colorful oceans and sprawling continents below look like up close.

Sound too far-fetched?

Not to Brian Tillotson. He can see it happening. He's the systems technology chief engineer for Boeing Research & Technology and a Senior Technical Fellow in Seattle, who dabbles on the side as a science-fiction writer. He specializes in space travel and robotics in his job. He's someone with subject-matter knowledge and a vivid imagination.

Coinciding with Boeing's centennial celebration, Tillotson and several of his Boeing Technical Fellowship colleagues were asked to ponder the future, to envision possible advancements in their fields of expertise—some 20, 50 or even 100 years out.

Collectively, they've come up with a world filled with airplanes that cross the oceans in a couple of hours; rotorcraft that replace the personal vehicle and commuter airplanes; interchangeable advertising on jet exteriors; airliners created entirely by 3-D printers; lasers used on unmanned aircraft for missile defense; an almost telepathic exchange of information; and a far greater robotic presence in the workplace. And, of course, planet Earth as a destination rather than a starting point.

"I can actually see that as a very plausible future—that Earth will be a highly desired vacation spot," Tillotson said.

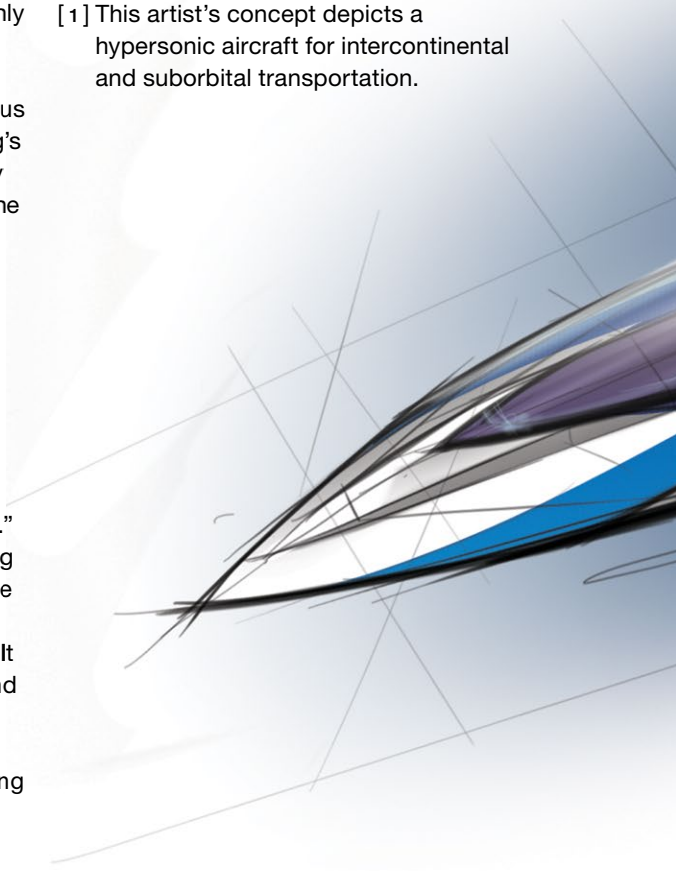
It's a vision based on humankind's natural spirit of adventure and its continuous desire to explore the universe, plus Boeing's ability to create cutting-edge technology that keeps up with ever-changing times, he said. In this case: a space colony. People already are thinking about it.

"Nobody's really built one of those, but we've got some concept work," Tillotson said. "It's really how do you do the plumbing, mow the grass, and raise and educate children in an environment like that? There are a lot of details to be worked out and Boeing is the logical company to do the huge majority of that."

To make this happen, however, Boeing likely will need to create a reusable space plane for transport, one that might rely on hypersonic principles for propulsion. It could double as a commercial airliner and make Earth easier to navigate, too.

Consider the following workday: A Boeing business person boards a morning flight in Los Angeles, rides two hours across the Pacific Ocean to Melbourne or Tokyo, attends a business meeting, returns to California that afternoon, and sleeps in his or her bed that night. This is Kevin Bowcutt's vision of the future.

President Ronald Reagan spoke of something similar in his State of the Union address in 1986, referencing a mythical Orient Express airplane that would ferry people halfway around the world in an hour or two. Reagan's pronouncement inspired Bowcutt, then a young hypersonics researcher, to pursue this project. He continues to work on it.

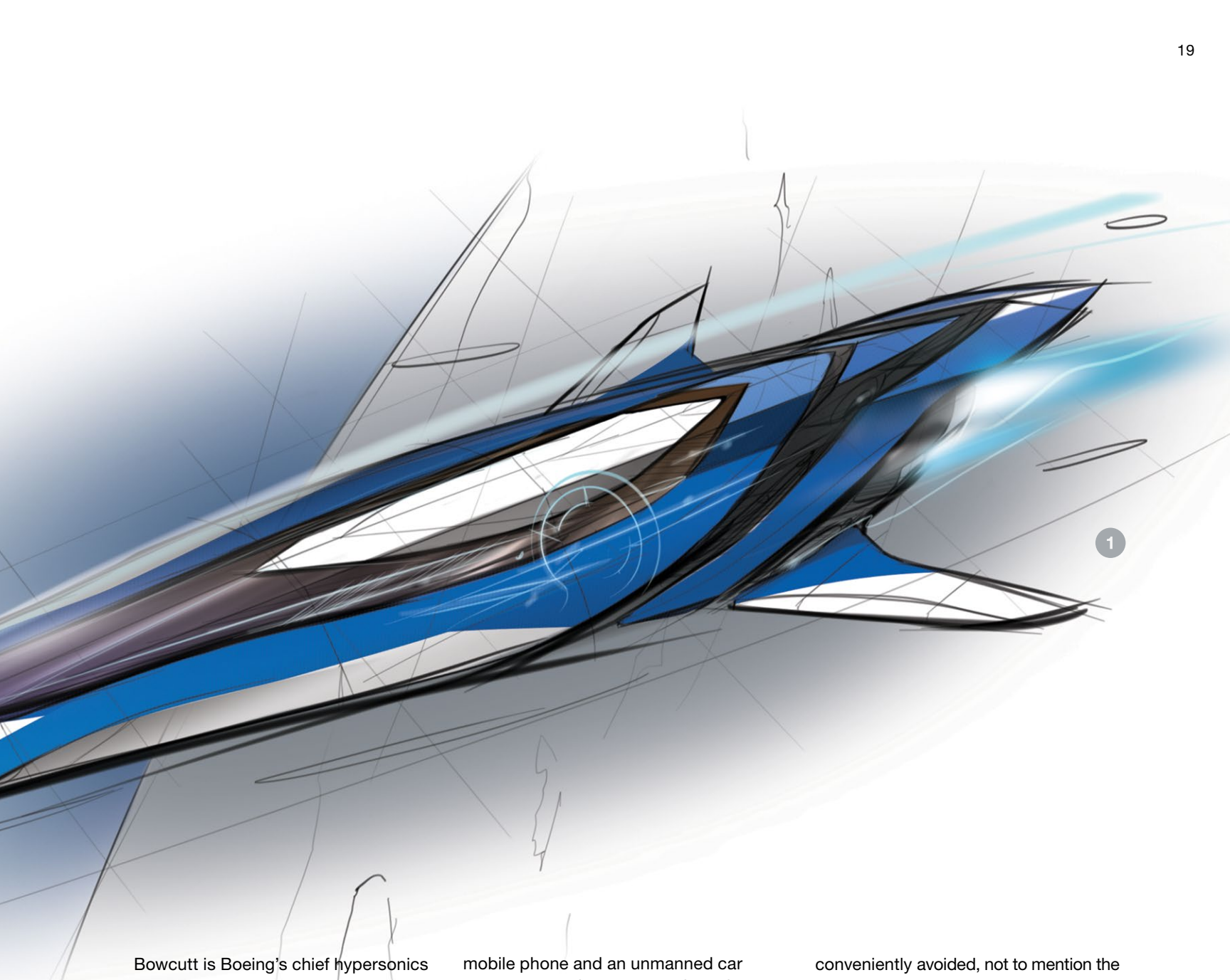


[1] This artist's concept depicts a hypersonic aircraft for intercontinental and suborbital transportation.

1928

Model 80 commercial transport

Boeing introduces the Model 80, an 18-seat passenger plane that carries the world's first flight attendants.



Bowcutt is Boeing's chief hypersonics scientist and a Senior Technical Fellow in Huntington Beach, Calif. He's determined to create a hypersonic aircraft that revolutionizes travel in outer space and across the planet. Over the past decade, he helped push this concept forward with successful trials using the experimental, unmanned X-43A and X-51A hypersonic vehicles, both of which relied on scramjet engines, or air-breathing propulsion that requires no turbo-machinery.

A hypersonic airplane would fit perfectly into what Bowcutt predicts will be a fully automated world someday, making time an even more valuable commodity.

"You could type in 'Paris' on your mobile phone and an unmanned car comes to your house, your phone beeps, and you go out and hop in," Bowcutt said. "It takes you to the airport and it takes out your luggage, and you get on an airplane or some hypertube-type thing that takes you across the ocean. It's just wild to think about where all this stuff is going to go."

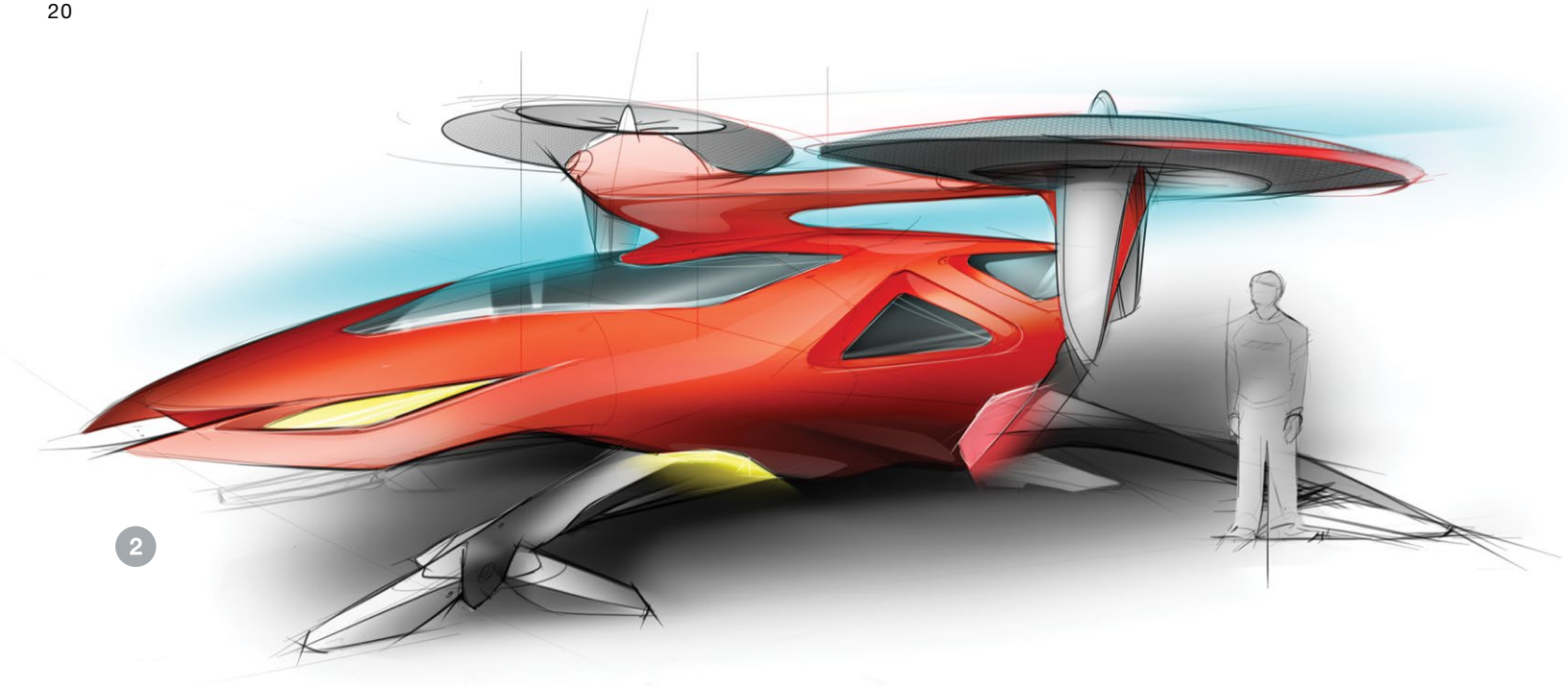
That's providing a car hasn't been rendered obsolete by then. Dan Newman, a Senior Technical Fellow at the Boeing Philadelphia site, envisions a future in which a rotorcraft lifts off from a residential driveway in a metropolitan area and whisks someone to work or the entire family to a relative's house for a holiday dinner. Rush-hour traffic and airport congestion are conveniently avoided, not to mention the overall car ride.

This Boeing aircraft that uses vertical flight might resemble a quadcopter, a configuration currently found in unmanned aerial systems or hobby toys, and it might have electrical power distribution instead of gearboxes and drive shafts, creating all sorts of options for rotorcraft

> "Earth will be a highly desired vacation spot."
>
> BRIAN TILLOTSON

1929

United Aircraft and Transport Corp., or UATC (William Boeing's conglomerate), is established.



2

[2] This concept depicts a personal rotorcraft used for commuting and private transportation.

[3] An orbital drone laser defense would protect against asteroids and meteors.

design, according to Newman.

As a result, airports and runways might become the exclusive domain of large jetliners that travel across the country or internationally, Newman said. Vertiports would be commonplace, constructed on the tops of city buildings or on seaport barges, to service the rotorcraft. Small airplane use might be eliminated or greatly curtailed because of this. Convenience would be the motivator. Newman thinks all of this is possible.

"The target distance for vertical flight to be valuable is where you take the four-hour car ride and turn it into a 40-minute flight," Newman said. "Up to 400 miles is where there is valuable time savings with vertical flight, portal to portal. I think the future will include more runway-independent aircraft. We're Boeing and if it's going to happen, we're the ones to do it."

Jill Seebergh is a Boeing chemical engineer and Senior Technical Fellow in Seattle who specializes in coating materials and processes. She looks for ways to make aircraft more fuel-efficient, environmentally sound and cost-effective to build and operate.

In the future, Seebergh sees a Boeing jetliner parked at the gate with images

1931

Y1B-9 bomber
The first Boeing monoplane bomber, the B-9 (Model 215) revolutionizes bomber design.

changing on the exterior. The airplane no longer has a painted livery. Instead, the surface is controlled by a lighting system, perhaps an active matrix organic light-emitting diode display, or AMOLED, offering the airline's identifying logo and colors—and maybe an advertisement.

"Picture a high-definition TV or smartphone screen, but one that is flexible and wraps around the aircraft—or spacecraft," Seebergh said. "You can do livery that way, but you can change it. You can reprogram it. Maybe there's a market for advertising, where advertisers pay for two weeks on the tail. There's a lot of flexibility to change the look. That would be exciting."

It also might have military applications in platform camouflage.

Seebergh also has a futuristic vision for the airplane interior: a self-cleaning cabin, featuring new technology that kills all surface bacteria, consequently alleviating passenger concerns over germ transmission from fellow travelers in close quarters. That may not be all that far away. Boeing engineers and designers have already built a prototype lavatory that uses ultraviolet light to kill 99.99 percent of pathogens, thus sanitizing all the lavatory surfaces.

Jeff Crouch and Jay Carskaden are engineers and Senior Technical Fellows who work in the Seattle area. Crouch deals with the smooth, uninterrupted flow of air over a wing contour or other airplane part (known as laminar flow); Carskaden specializes in engines and propulsion.

Crouch sees a lot of airplanes entering service in the decades to come but no new airports to support them. To offset future traffic jams, a push could be made to reduce or break up wake turbulence, enabling jets to trail closer to one another and get on the ground quicker, he said. Future aircraft wings might become significantly thinner with longer wingspans and large regions of laminar flow for improved efficiency, he said.

Carskaden experienced firsthand one of the most radical changes in the direction of the modern aviation world—the move from most jetliners having three and four engines to just two. Greater airspeed might be the next defining moment, he believes, even before a hypersonic aircraft is created.

More speed, however, means less fuel efficiency and corresponding cost. The challenge will be finding ways to neutralize or reverse that, especially when carbon-neutral fuels, or so-called biofuels, are considered to address environmental concerns, Carskaden said. But there are plenty of incentives to get to places faster, he added.

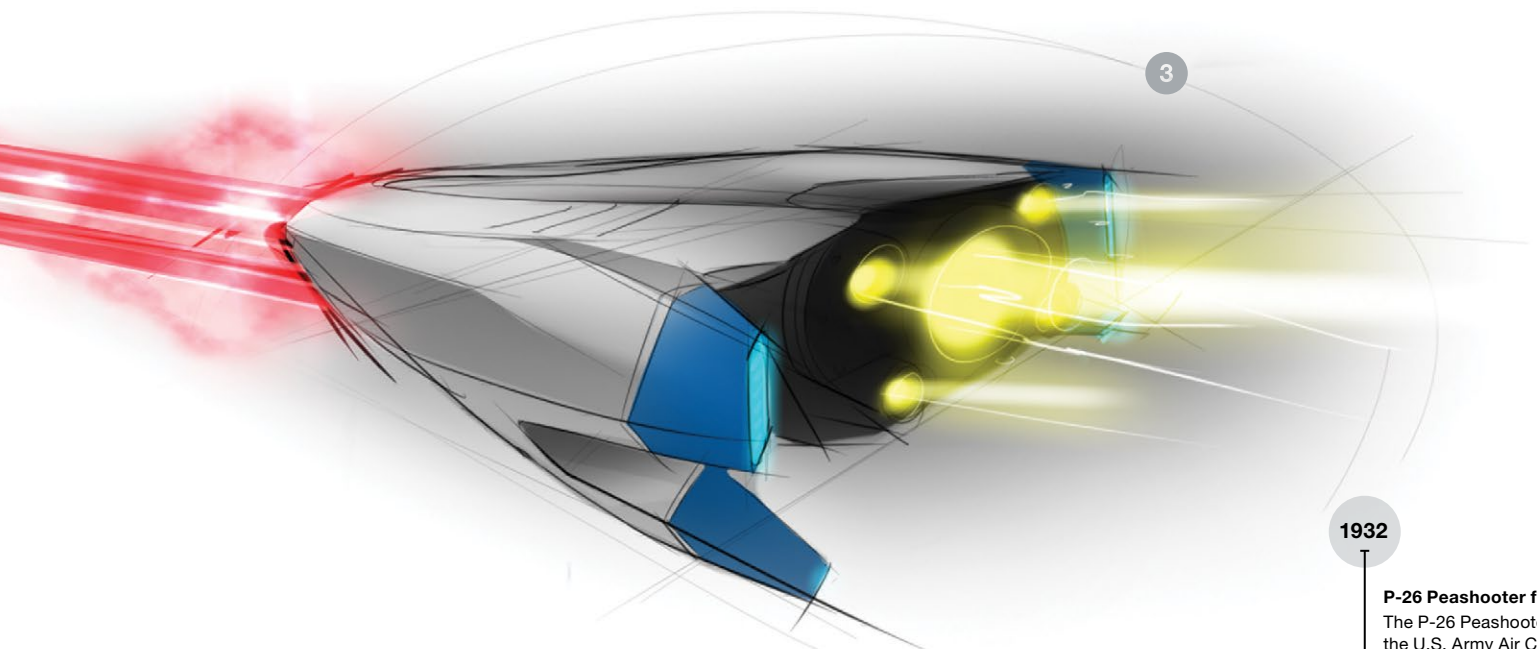
"Because speed costs money, how fast do you want to go?" Carskaden asked hypothetically. "We will keep trying to seek out ways to connect the parts of the globe that today kind of test the limits of human endurance riding on an airplane. It's amazing that we can actually connect those parts of the world in 16 or 18 hours, but it's a long time to sit in a cabin."

> "Imagine taking the design of an airplane to a factory-sized 3-D printer by which employees literally print the entire airplane in that spot, roll it out and fly it away."
>
> TOM GRANDINE

Taking a glimpse of the distant future, Carskaden next raised a possibility featured in the fictional TV series *Star Trek*—transporter devices that instantly move people from one place to another. "We could all be trumped by transporter technology in 100 years," he said playfully.

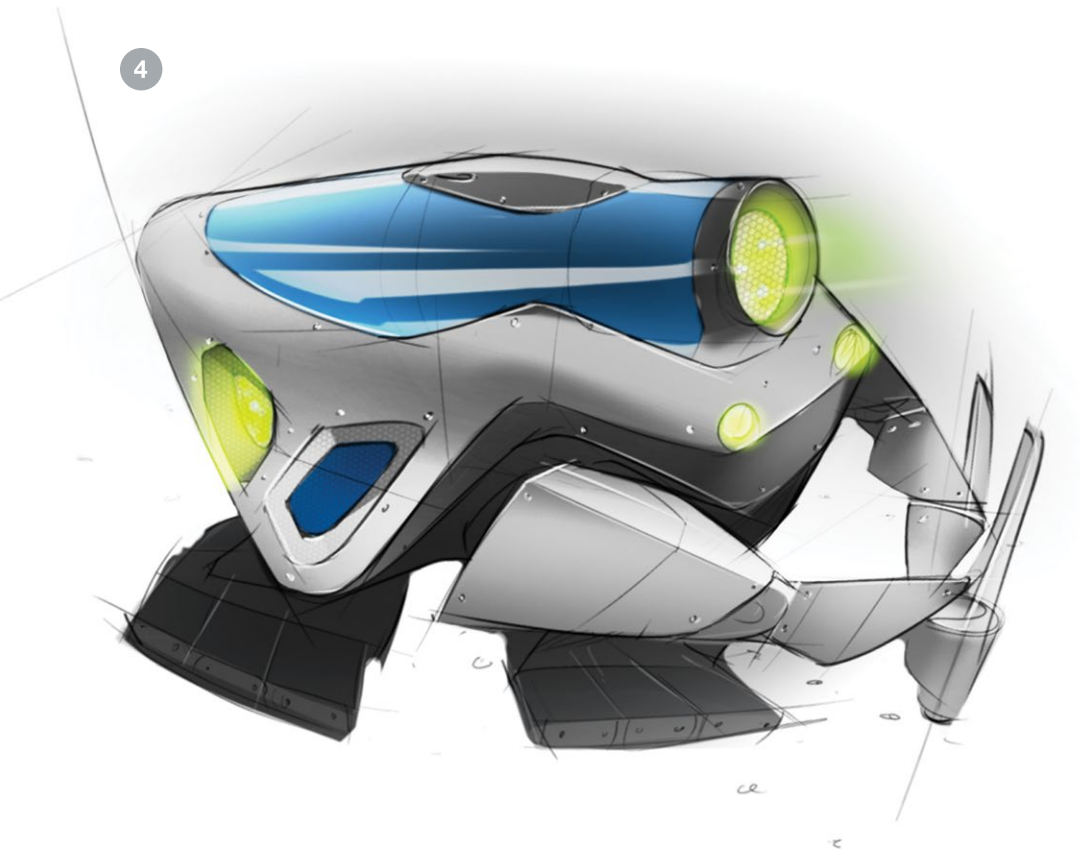
Regardless of the technology that results, Carskaden remains convinced Boeing will play a big part, adding, "We could walk into something magical."

Tom Grandine, an engineering specialist



1932

P-26 Peashooter fighter
The P-26 Peashooter is the U.S. Army Air Corps' first production all-metal monoplane fighter.



[4] Difficult manufacturing tasks could be performed by a riveting robot.

[5] This artist's concept depicts a wiring robot.

in geometric modeling and numerical analysis and a Senior Technical Fellow in Seattle, also takes a page from *Star Trek* when talking about the future. He and his team members create virtual simulations that can make airplane production prototypes unnecessary and, in turn, save significant cost. The downside is modeling can take months, even years, to complete.

Grandine also sees future modeling becoming more in tune with something featured in *Star Trek*, where new devices are created almost instantaneously using verbal commands to a computer.

He also envisions Boeing someday having the ability to link all of its hundreds of thousands of laptops and computers into one data stream, using an automated process turned on by something as simple as a screen saver and scanning for ideas and designs. They would be filtered for compatibility, connecting everyone across the enterprise like never before, he said.

Taking modeling one step further, Grandine said digital manufacturing might be a far more involved process in the future, both in customizing the airplane build and possibly replacing all tooling. He envisions more concentrated 3-D printing on the assembly line.

"I suspect we're still decades away from this, but imagine taking the design of an airplane to a factory-sized 3-D printer by which employees literally print the entire airplane in that spot, roll it out and fly it away," he said.

Lasers will become smaller and be more powerful as the technology continues to evolve over the next couple of decades, according to Harold Schall, Boeing Laser & Electro-Optical Systems chief engineer and Senior Technical Fellow in Albuquerque, N.M.

Schall was part of the Star Wars program, which began in the 1980s and later led to tests of a laser anti-ballistic missile system on a modified 747. In the future, he said, Boeing's unmanned aerial systems might rekindle this type of defense effort—with a much smaller laser.

"You could put a laser on a Boeing unmanned vehicle and advances could be made where you will be able to get enough power in that laser to go back and do the Star Wars mission on that platform, only more efficiently and with smaller volume," Schall said. "It could be a high-altitude vehicle that will stay up for days to protect the country."

Emily Howard is a human factors engineer and Senior Technical Fellow based in Huntington Beach, Calif., who specializes in human information processing. Her job is to help ensure that everything Boeing develops—products, tools and services—enables employees and customers to be effective, efficient and safe. "My work is not rocket science, but it is based on brain science, and the next century will see a tremendous change in how we understand, harness and amplify the power of the human brain," she said.

Almost everything being built these days has a sensor, a display, a network, Howard noted. Technology of all kinds revolves around the increasing hunger for information and machines are becoming more involved in everyday decision-making,

1933

Model 247 commercial transport
The Boeing Model 247 is the world's first modern airliner.

if only to manage the sheer volume of information available. Machines someday will augment human thinking as much as they have revolutionized human physical abilities, she said.

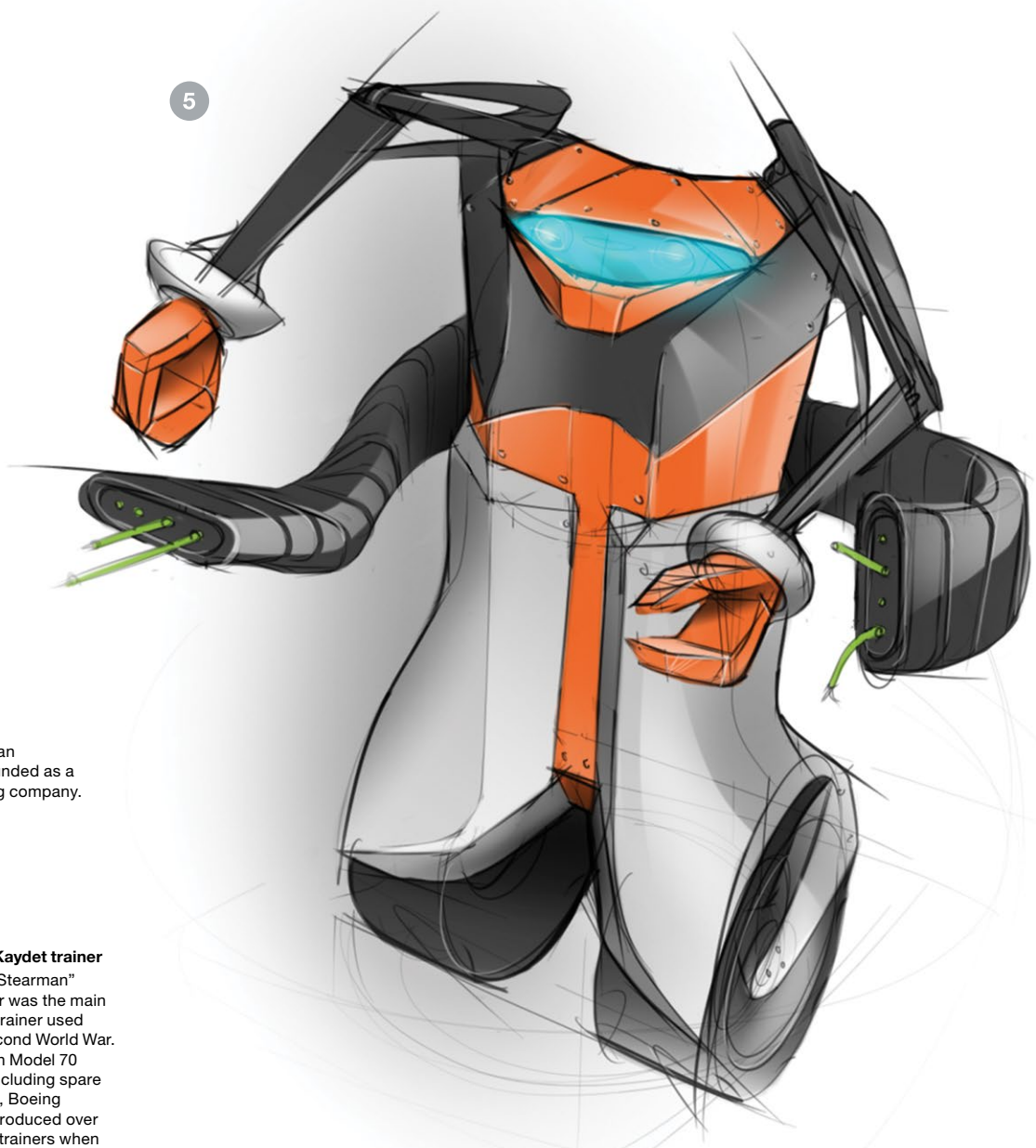
Howard sees a future that involves a much more immediate exchange of knowledge, such as thoughts and ideas from person to machine or even person to person, using technology as an enabler.

"We will be inserting information, injecting it directly into the human brain, and, in turn, translating human thought into complex commands," Howard said. "Whether Boeing owns that technology or whether we just use it, we will be transferring information from a senior mechanic or engineer to a novice, training our users in a fraction of the time, and ultimately designing and operating aircraft simply by thought."

Finally, 100 years from now, it won't be all that surprising to view a Boeing factory floor, and perhaps other Boeing work environments, where artificial intelligence has a more substantial presence, according to Tillotson, the systems technology chief engineer for Boeing Research & Technology. He envisions robots performing a majority of the structural work in the future, able to do repetitive and strenuous tasks without interruption. Employees instead would guide and supervise the work in high-tech jobs that require human reasoning, troubleshooting and decision-making capabilities. Another benefit would be the elimination of work-related injuries.

Robots eventually will be more adept at processing information and coming up with ready answers than humans, turning engineering into a more automated process, he said.

"It will be a real interesting challenge for Boeing, as well as broader society," said Tillotson, "to see what the role is for us when we have machines that are so very capable." ●



1934

North American Aviation is founded as a manufacturing company.

UATC is split up and Boeing Airplane Co. is re-established.

PT-13/PT-17 Kaydet trainer
The famous "Stearman" biplane trainer was the main U.S. primary trainer used during the Second World War. Beginning with Model 70 in 1934 and including spare parts and kits, Boeing Wichita had produced over 10,000 of the trainers when production ended in 1944.

P-51 Mustang

This North American Aviation warplane proved as versatile as any of its time, serving during World War II as a fighter, bomber and escort. It was particularly effective at providing long-range, high-altitude escort for U.S. bombers on daylight bombing missions over Europe and in the Pacific. The Mustang's superior aerodynamics, including its pioneering laminar flow wing, allowed it to outperform enemy fighters. The P-51 flew for the first time on Oct. 25, 1940, and it remained in service for the Korean War and for foreign military use well into the 1980s. North American, a Boeing heritage company, built more than 15,500. ●

A FLIGHT OF NORTH AMERICAN B-25 MITCHELL BOMBERS HAMMERS THE AXIS IN NORTH AFRICA

NORTH AMERICAN PLANES MAKE NEWS AROUND THE WORLD

Mitchell and Mustang Take Part in Six of "Big Ten" Stories

"NAMES MAKE NEWS"—and two great names in the war news are the North American B-25 Mitchell bomber and the North American P-51 Mustang fighter. In a recent press association list of 1942's ten biggest war stories, there were SIX in which these planes figured!

Here are the roles they played: (1) North American B-25's bomb Tokyo. (2) B-25's play a major part in smashing Rommel's Afrika Korps. (3) North American P-51 Mustangs harass enemy in sweeps over Europe. (4) B-25's aid great Russian winter offensive. (5) B-25's destroy Jap ships, airfields, munitions in New Guinea. (6) Mustangs provide strong aerial support over Dieppe.

North American planes are making even bigger news in 1943 because they are even better than last year. Here at North American we refuse to "freeze" design. Improvements are being made constantly based on past battle experience and anticipation of future tactical needs. Today's B-25, for instance, is more than 22,000 drawing changes better than the B-25's that bombed Japan eleven months ago!

This policy of constant improvement demands extra work and extra ingenuity from every North American employee. But it's worth it. It will win the war sooner — days, weeks or even months. It will save many lives. It will give each of us plenty to cheer about as we read the news North American planes will make on every battlefront from now 'til victory.

NORTH AMERICAN AVIATION, INC.
Inglewood, California
Kansas City Dallas
Member, Aircraft War Production Council, Inc.

THE FIRST AMERICAN PLANE designed entirely on basis of combat experience — that's the North American P-51 Mustang. Heavily armed, maneuverable, one of the world's fastest. American and British flyers call it "the best fighter plane of 1943."

NORTH AMERICAN *Sets the Pace!*

B-47 Stratojet

Boeing produced the world's first large, swept-wing jet for the U.S. Air Force, and its revolutionary design directly contributed to the development of the modern commercial jetliner. The B-47's swept wings were angled back at about 35 degrees; another key innovation was placing the engines on pylons beneath the wings, enclosed in pods. The six-engine bomber flew for the first time on Dec. 17, 1947. The B-47 was followed by Boeing's B-52, which became the mainstay heavy bomber for the U.S. Air Force and is still in service today. Every large swept-wing jet is a descendant of the B-47. ●

You're looking at tomorrow!

One glimpse of the great new XB-47, built by Boeing for the U. S. Air Force, will project you far into the future. For here is an airplane startlingly different in design—as revolutionary today as was the first Boeing Flying Fortress in 1935. It is the first bomber specifically designed to utilize all the aerodynamic features believed necessary to take full advantage of jet propulsion.

How fast will it fly? The actual figures must remain a military secret, but its arrow-like lines and enormous power are enough to tell you it was designed for terrific speeds.

It's a big airplane—roughly the same size as the famous Boeing B-29 — and can carry a ten-ton bomb load. Six turbo-jet engines give it a rated thrust of 24,000 pounds—the equivalent of nearly three times the power of the Superfortress.

But the most significant fact about the XB-47 Stratojet is its radically new aerodynamic design.

The slim, swept-back wing and tail surfaces, sleekly beautiful body lines, streamlined nacelle mountings and tandem landing gear look ahead to the era of supersonic speed.

Boeing leadership in research and engineering has given the nation the B-17, the B-29 and, more recently, the great new B-50. Now it opens new vistas for American Air Power in the realm of jet-propelled flight.

Boeing test pilots Robert Robbins and Scott Osler, who took the Stratojet up for its history-making first flight.

For the Air Force, Boeing is building the B-50 bomber, XB-47 jet bomber and C-97 transport; for the Army, the L-15 liaison plane; and for six major airlines, the twin-deck Boeing Stratocruiser.

BOEING

We make Boeing

PHOTOGRAPHY BY
BOB FERGUSON | GAIL HANUSA | MARIAN LOCKHART | ALAN MARTS
TIM REINHART | FRED TROILO | ASSOCIATED PRESS

William Boeing was 22 years old when Orville and Wilbur Wright flipped a coin to decide who would make that first powered flight at Kitty Hawk, N.C. That same year, Boeing left engineering college at Yale and headed West, where he eventually settled in Seattle. It was there that Boeing and a friend, Conrad Westervelt, a Navy engineer, took a few flights one day in a barnstormer's biplane over Lake Washington. Afterward, Boeing told his friend he thought they could make a biplane better than any on the market. And so they did, in a boathouse on the shores of Seattle's Lake Union. The twin-float seaplane was named after their initials—the B&W. On July 15, 1916, Boeing incorporated his airplane manufacturing business.

Boeing's company later grew to include Douglas Aircraft, North American Aviation, McDonnell, Hughes Space and Communications, and others. These "heritage" companies, too, had been founded by aviation and aerospace visionaries. What they all had in common were men and women who helped give wing to aviation and aerospace discoveries that changed the world—even put humans on the moon.

Today, nearly 160,000 people work at The Boeing Company, in offices and factories in more than 60 countries around the world. Regardless of where they work or what they do, whether they are part of design and test or build and support efforts, they are the foundation of the company, its bedrock. The photo essay that follows highlights the work they do across the company and across the globe. Collectively, they enable the company to continue to do amazing things, and carry on that legacy of innovation and excellence into Boeing's second century.

1935

B-17 Flying Fortress bomber
The B-17 Flying Fortress served in every World War II combat zone—more than 12,000 were built.

DC-3 commercial transport
The DC-3 is the first aircraft to make money carrying passengers rather than mail; it can fly coast to coast in 16 hours.

Employees move a B&W seaplane at Bill Boeing's boathouse on Lake Union in Seattle.

[1] Propulsion South Carolina teammates inspect a 737 MAX engine inlet prior to shipping to Final Assembly in Renton, Wash.

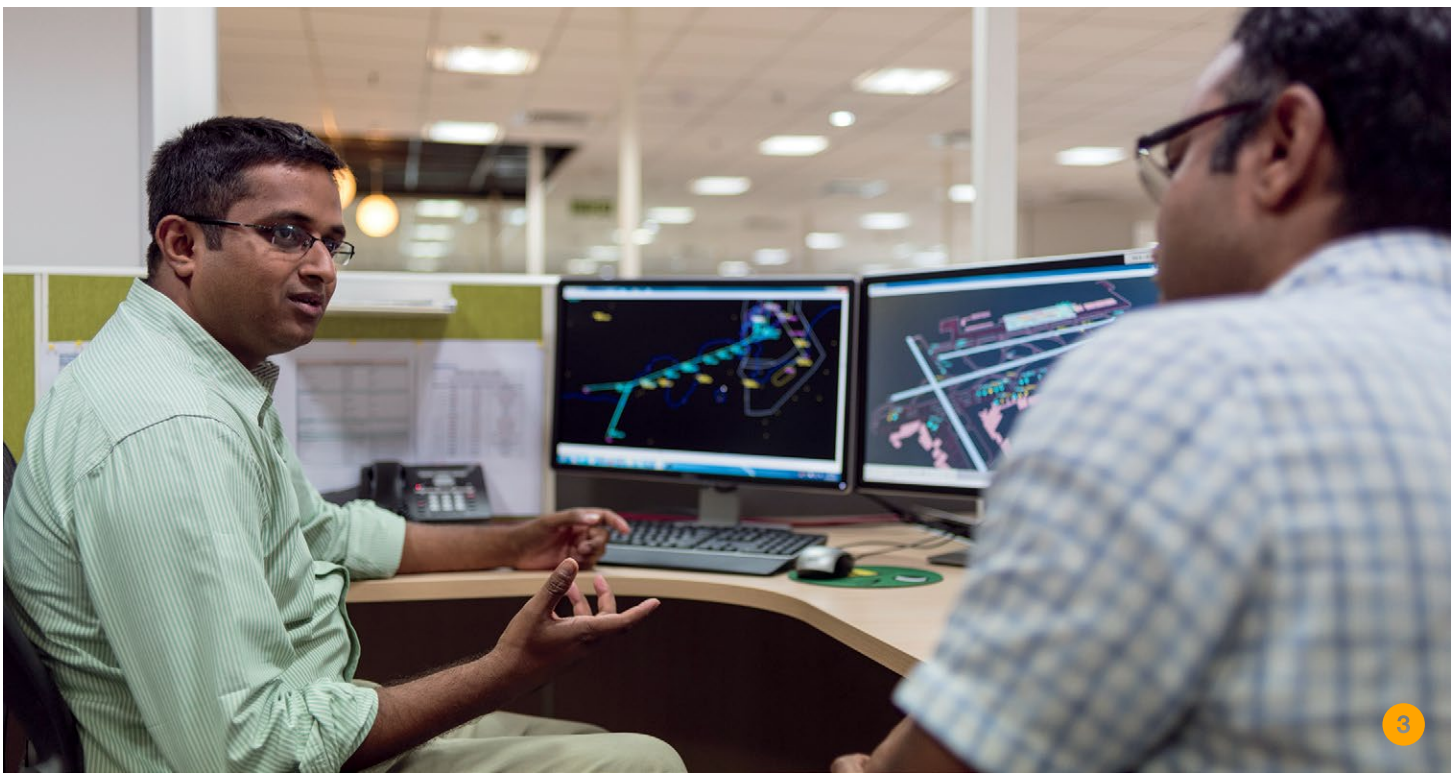
[2] Engineering and Immersive Development teammates at Boeing Philadelphia use interactive Virtual Reality technology to visualize and integrate design concepts.

design

1936

BT-9/NJ-1 trainer
The BT-9 is the first production North American Aviation trainer.


2



[3] Software engineers at the Boeing Enterprise Engineering Center in Bangalore, India, work on development of a simulation product for Jeppesen, CAS Digital Aviation.

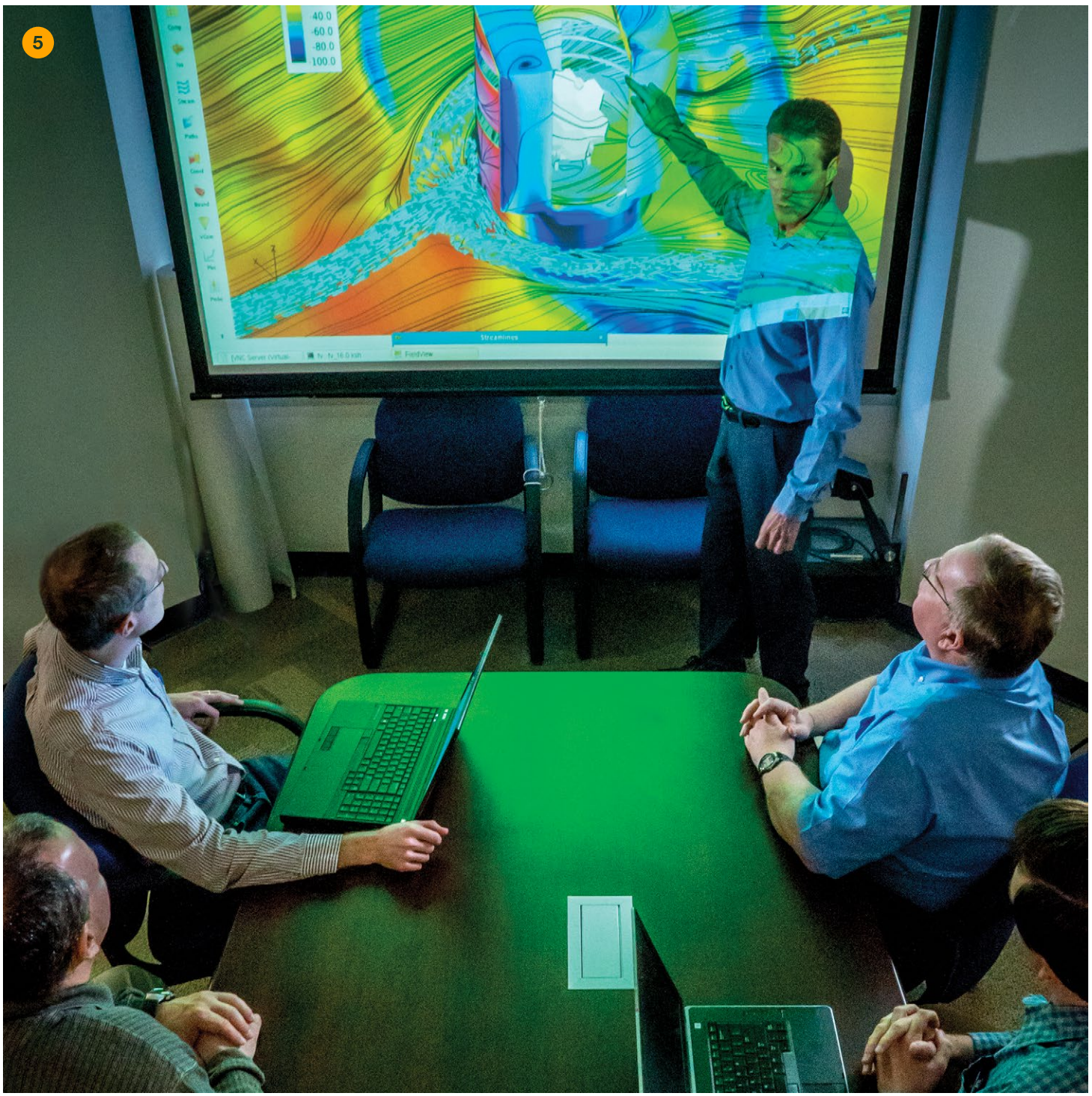
[4] Volunteers in Everett, Wash., participate in a design challenge to help prepare them to teach science and engineering concepts to students and their families.

[5] In St. Louis, a Boeing Research & Technology team reviews Computational Fluid Dynamics, or CFD, simulations of design concepts for the Giant Magellan Telescope, which is being built in Chile.

1938

Model 314 Clipper flying boat
The Boeing Model 314 Clipper, the largest passenger transport of its time, carried 74 passengers and included a lounge, dining salon and bridal suite.

T-6 Texan military trainer
The North American T-6 Texan two-place trainer is the classroom for most Allied pilots in World War II.



McDonnell Aircraft Corporation

1939

McDonnell Aircraft Corp. is founded.

In Everett, Wash., engineers design the 777X composite wing.

1940

B-25 Mitchell bomber
The North American Aviation B-25 served in every theater of WWII and with every Allied air force as well as all branches of the U.S. military—9,817 were built.

P-51 Mustang fighter
North American Aviation's P-51 Mustang, arguably the best fighter of World War II, introduced the laminar flow wing.

1941

C-47 Skytrain military transport
The Douglas C-47, a military variant of the DC-3, goes into production. It plays a major role in the D-Day invasion and the Berlin Airlift.

1942

B-29 Model 345 Superfortress
The Boeing B-29 bomber makes its first flight. It is one of the most technologically advanced airplanes of World War II and the first heavy bomber to have a pressurized cabin.

[1] Boeing pilots flight-test the AH-6 Little Bird in Mesa, Ariz.

[2] A Boeing Test & Evaluation team performs structural tests on 777X wing panels at the High Loads Center in Mesa.

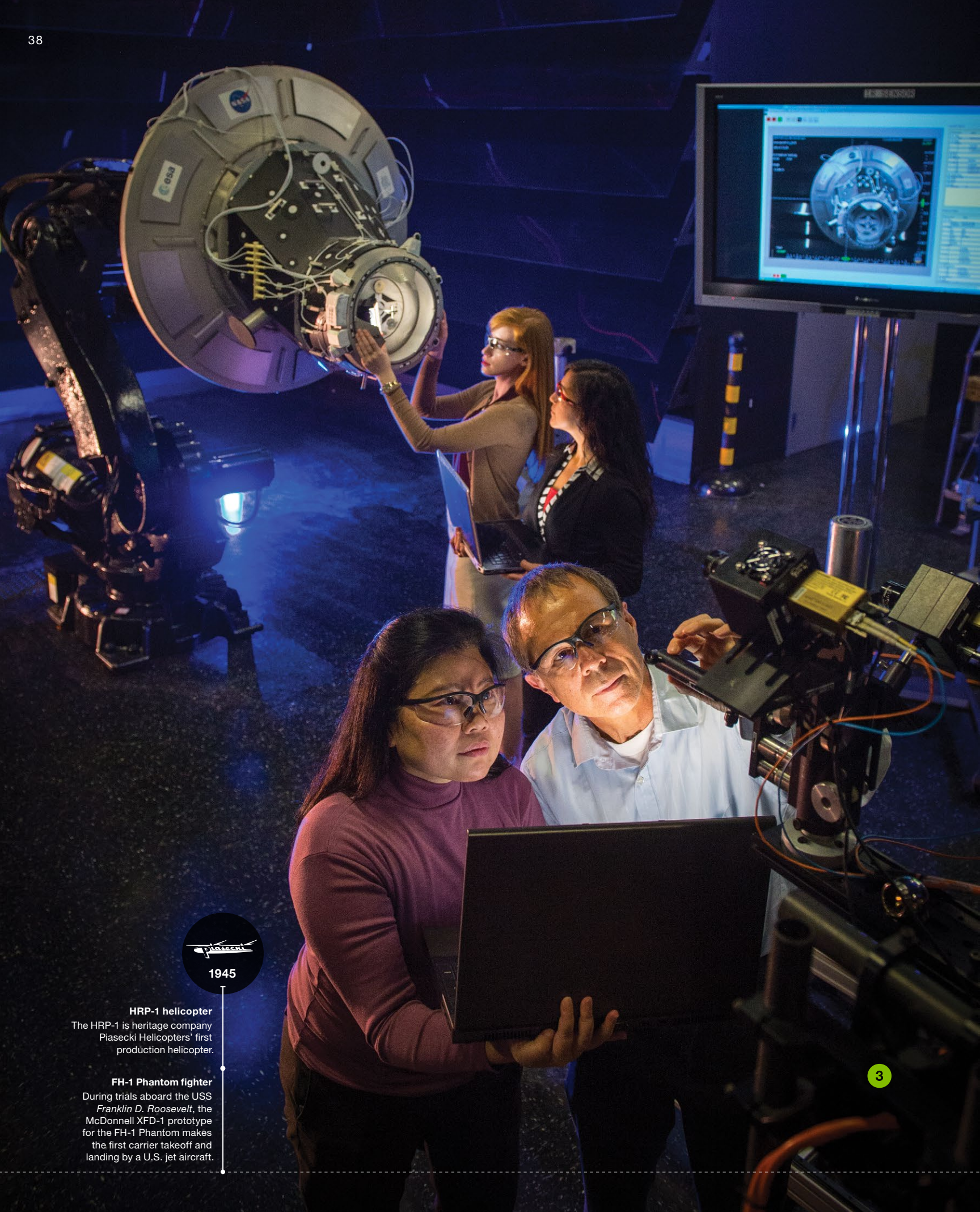
1

test

1944

C-97 Stratofreighter military transport/tanker
In all, 888 C-97s were built including the world's first production aerial tanker—the KC-97.


2
END A
Northwest



1945

HRP-1 helicopter
The HRP-1 is heritage company Piasecki Helicopters' first production helicopter.

FH-1 Phantom fighter
During trials aboard the USS *Franklin D. Roosevelt*, the McDonnell XFD-1 prototype for the FH-1 Phantom makes the first carrier takeoff and landing by a U.S. jet aircraft.

[3] In Huntington Beach, Calif., a Phantom Works team tests the CST-100 Starliner autonomous relative navigation system.

[4] In North Charleston, S.C., team members from Boeing Research & Technology, Information Technology and Commercial Airplanes test a 787 part using MobileQS, a Boeing system designed to improve flow time and increase accuracy.

1946

DC-6 commercial transport

Douglas propliners, including the DC-4 and DC-7, dominated the postwar commercial aviation market. The DC-6 was the first airliner to fly a regularly scheduled around-the-world route. Douglas built 704 DC-6s.

At various sites, including New Mexico (shown), Boeing develops laser and electro-optical systems that harness the power of directed energy for weapons concepts and surveillance systems.

BOEING

1947

B-47 Stratojet bomber
The Boeing B-47 Stratojet was the world's first large swept-wing, multi-engine jet and forerunner of all large jets produced today.

F-86 Sabre Jet fighter
North American Aviation introduces the XP-86 Sabre Jet. It is America's first swept-wing jet fighter.


BOEING

1951

F3H Demon fighter
The F3H Demon is the first swept-wing jet fighter designed by McDonnell Aircraft and the only single-engine carrier-based fighter built by the company.

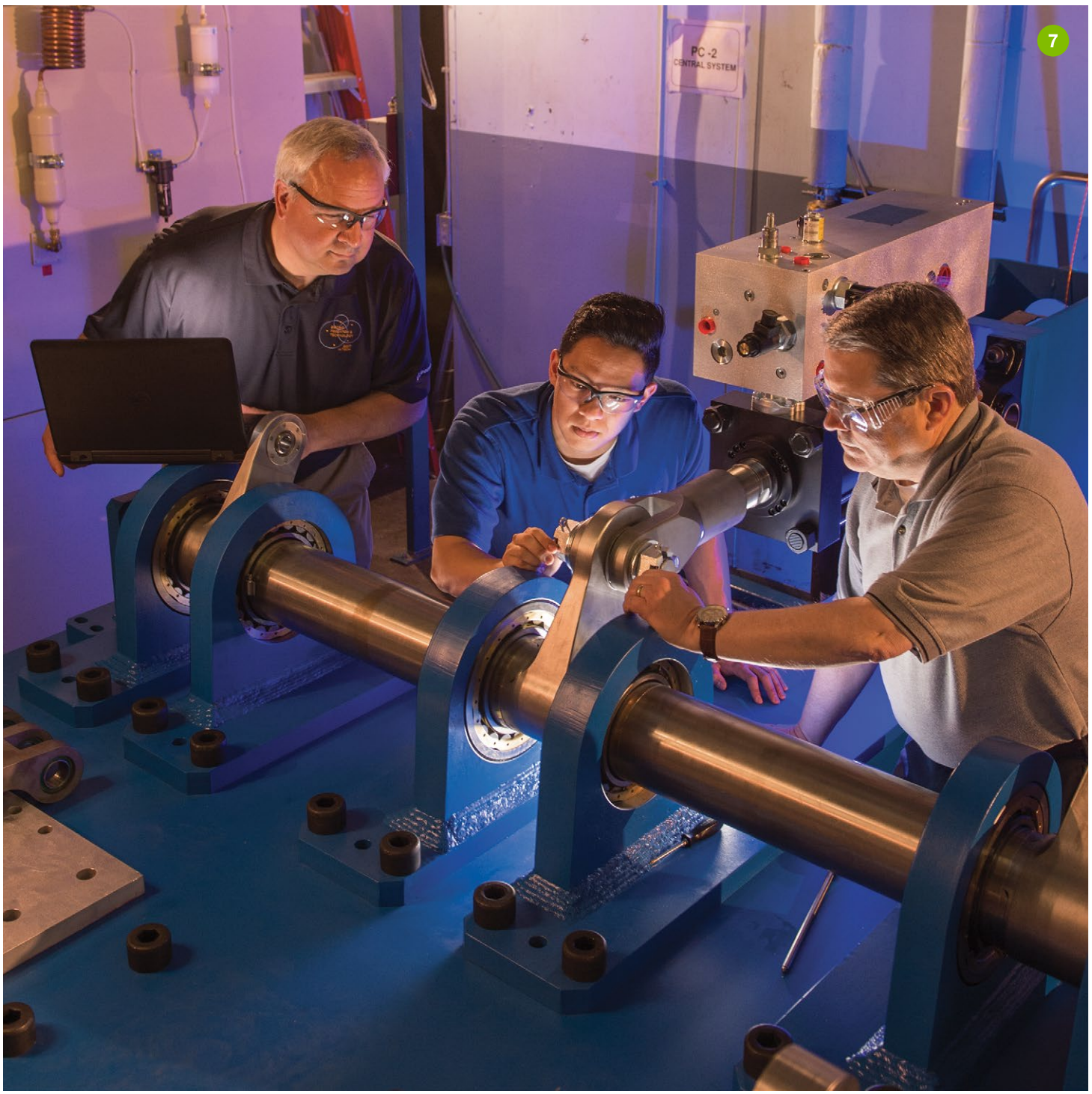
[5] Boeing Research & Technology–China leads in-country research collaborations on magnesium alloys toward lighter airplane structure.

[6] In an advanced human systems integration lab in Missouri, a Boeing Research & Technology team helps improve the interaction between humans and machines.

1952

B-52 Stratofortress bomber

The B-52 Stratofortress, an eight-engine, 390,000-pound (176,900-kilogram) jet, is the country's first long-range, swept-wing heavy bomber.



7

1953

F-100 Super Sabre fighter
The North American F-100 Super Sabre is the first operational fighter in the world capable of maintaining supersonic speed in level flight.

[7] In a lab in Missouri, Boeing Research & Technology employees are helping the U.S. Air Force Research Laboratory develop adaptive, smart aircraft power systems.

[8] A team from Boeing and the U.S. Air Force prepares the KC-46A tanker for takeoff from Seattle's Boeing Field.

1954

A-4 Skyhawk light attack bomber

Douglas built 2,960 of the lightweight, cost-effective yet powerful carrier-capable jets for the U.S. Navy, Marines and friendly nations. The Skyhawk featured great altitude and range capabilities, plus an unusual flexibility in armament capacity.

Model 367-80 Dash 80

The Boenig Model 367-80—the Dash 80—is the prototype for the KC-135 Stratotanker, the world's first successful jet tanker and transport, and the Boeing 707, the world's first successful commercial jet.

CST-100 Starliner employees put the final touches on a spacecraft test article in the Commercial Crew and Cargo Processing Facility at Kennedy Space Center, in Florida.

1958

DC-8 commercial transport
The Douglas DC-8 is the first Douglas jet-powered transport.

F-4 Phantom II fighter
The McDonnell two-place, all-weather F-4 Phantom II twinjet can fly at more than twice the speed of sound.

VERTOL

1960

Boeing purchases Vertol Corp., formerly Piasecki.

[9] Boeing pilots prepare for a flight test of the EA-18G Growler in St. Louis.

[10] In Bingen, Wash., Insitu employees test and refine FLARES, an unmanned aerial system, or UAS, that will be responsible for launching and recovering another Insitu UAS, ScanEagle.

1961

CH-47 Chinook military helicopter
The Vertol Division's CH-47 Chinook, a multi-mission, heavy-lift transport helicopter, is designed to serve the U.S. Army and evolves into several versions.

Minuteman weapon system
The Minuteman weapon system, a long-range three-stage intercontinental ballistic missile, is capable of carrying multiple nuclear warheads.

[1] In El Segundo, Calif., employees review plans of an Intelsat Epic Next-Generation satellite, which is being built at Boeing's Satellite Development Center, the world's largest satellite factory.

[2] Employees from the 777X program and Site Services meet inside an autoclave at the Composite Wing Center in Everett, Wash.

build

DOUGLAS

1962

Mercury space capsule
John Glenn becomes the first American to orbit Earth in the McDonnell-built Mercury spacecraft.

2

1963

727 commercial jetliner

The Boeing 727 introduces triple-slotted flaps and other high-lift technologies. It remains one of the best-selling commercial jets of all time.


3

[3] A painter at the Renton, Wash., paint hangar applies a final clear coat to help prepare a 737 MAX for its first flight.

[4] Employees in Mesa, Ariz., work on the AH-6 production line.

1967

McDonnell and Douglas merge into McDonnell Douglas Corp.

North American Aviation merges with Rockwell Standard Corp., forming North American Rockwell Corp.

737 commercial transport

The Boeing 737, a smaller twinjet, complements the 707 and 727 to create the company's first family of jets.

At 1.2 million square feet (111,500 square meters) Boeing South Carolina's Final Assembly building opened in 2011 as the second production site for the 787 Dreamliner. The site now fabricates, assembles and delivers 787-8 and 787-9 models, and will be the sole production site for the 787-10.

1968

Apollo spacecraft

Apollo 8, designed and built by North American and launched by a Saturn V, takes three astronauts around the moon for the first time.

1969

747 commercial transport
The massive Boeing 747-100, the world's first widebody jet, has a total wing area larger than a regulation-sized basketball court.

[5] Boeing employees from Supplier Management visit a Chinook pylon assembly line at a supplier site in Bangalore, India.

[6] In South Carolina, an Interiors Responsibility Center production teammate installs hardware on a 787 Dreamliner stowage bin.

1972

F-15 Eagle tactical fighter
The McDonnell Douglas F-15 Eagle begins its long reign as an air superiority jet fighter.


6
2
CENTER B RH

Employees drill holes in the top panel of a 737 wing in Renton, Wash., before installing fasteners.

1973

North American Rockwell is renamed Rockwell International.

1974

B-1 Lancer bomber

The Rockwell (North American) B-1B Lancer is a swing-wing bomber intended for high-speed, low-altitude penetration missions. The B-1B Lancer first flew in 1984.

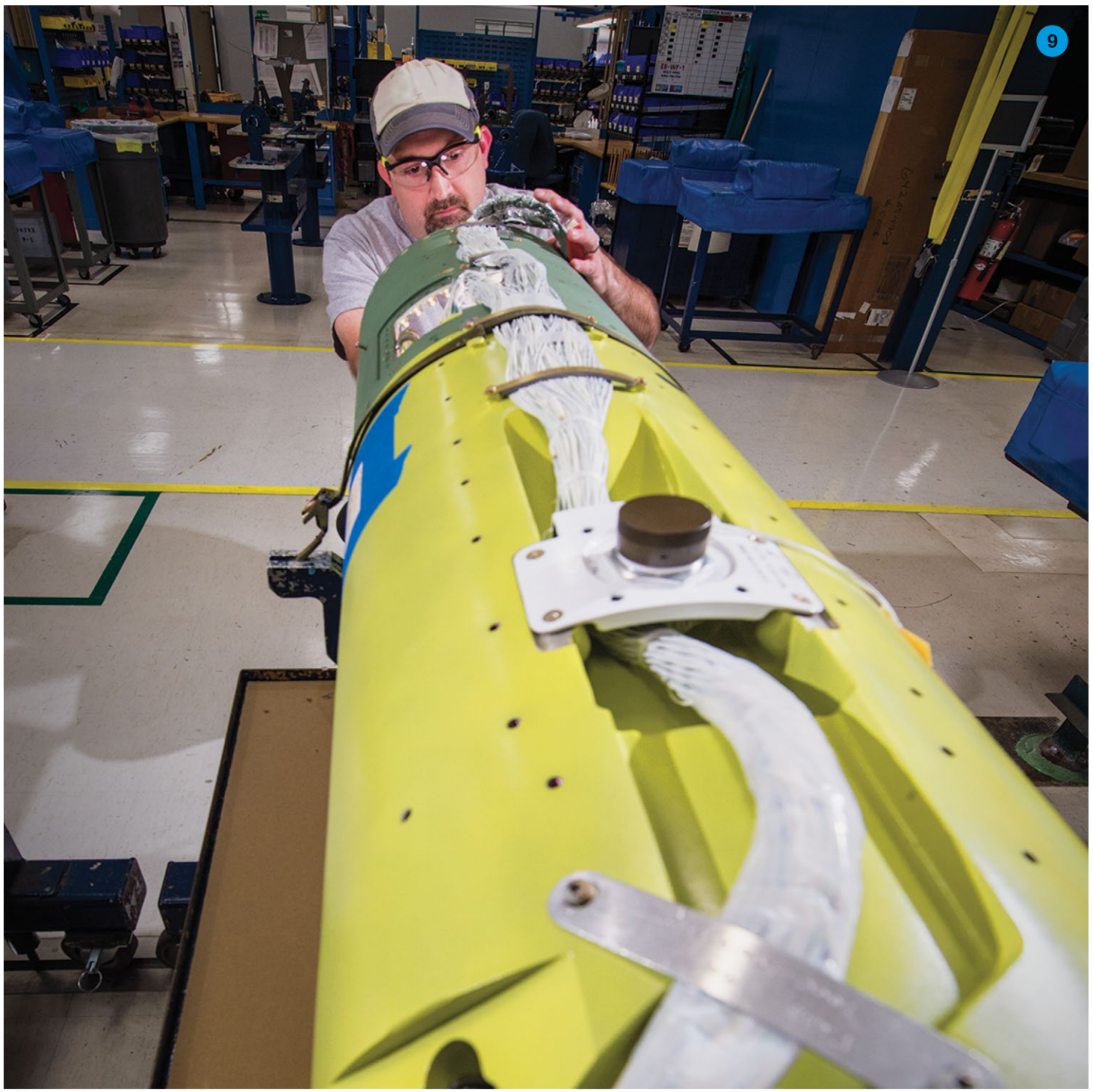

PANEL 4
7
HEATER POWER SUPPLY
CHA Industries
MAINTENANCE CONTROL
CHA Industries
INTERLOCK STATUS
CHAMBER DOORS
PANEL DOORS
WATER COOLING
VACUUM
MODES
VALVES
SHUTTER
PUMPS
SIMATIC FLAT PANEL
HEAT
GAS
DEPOSITION
VENT
SYSTEM IN STANDBY
INFICON
IC6
BEAM SWEEP CONTROL 1
LONGITUDINAL

[7] An employee from Boeing subsidiary Spectrolab monitors equipment used in the production of solar cells.

[8] In Melbourne, employees from Boeing Aerostructures Australia 737 Assembly and Boeing Research & Technology–Australia prepare a robot specifically designed to work alongside people.

1977

Space Shuttle orbiter
With first glide tested in the atmosphere in 1977, the Rockwell-built space shuttle flies into orbit in April 1981.



1978

F/A-18 Hornet fighter

The McDonnell Douglas F/A-18 multi-role fighter is designed for aircraft carrier duty and is the first tactical aircraft initially designed to carry out both air-to-air and air-to-ground missions.

[9] An assembly mechanic checks for foreign object debris prior to installing an engine on a Harpoon missile in St. Charles, Mo.

[10] An overhead view of 787 final assembly in Everett, Wash.

Employees of Boeing subsidiary Spectrolab inspect and clean solar space panels in California.

1981

767 commercial transport
A pioneer of a number of commercial aviation technologies, the 767 introduced ETOPS (Extended-range Twin-engine Operational Performance Standards) and along with the 757 originated the two-crew computerized “glass cockpit.”

1982

757 commercial transport
The twin-engine, medium-range Boeing 757-200 is up to 80 percent more fuel-efficient than the older 727 jetliners.

[1] At the Boeing Flight Services Campus in Singapore, employees take part in 787 classroom training.

[2] Employees at the Spares Distribution Center in Seattle operate specialized machines to select the right part from shelves 300 feet (90 meters) long and 60 feet (18 meters) high.

support

1987

Model 601 satellite
The body-stabilized Model 601 satellite, developed by Hughes Space and Communications, is designed to meet requirements for high-power, multi-payload applications.


2
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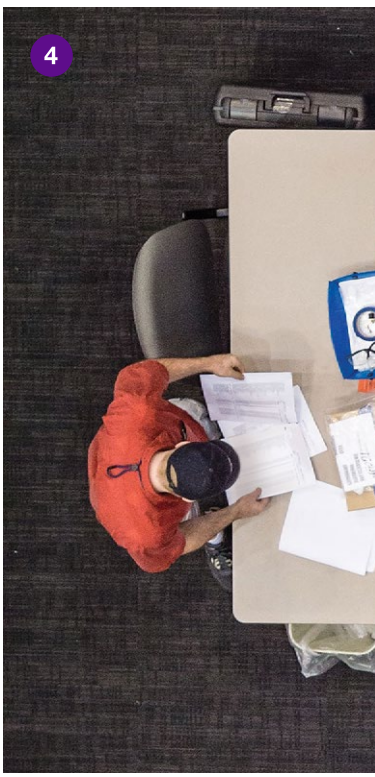
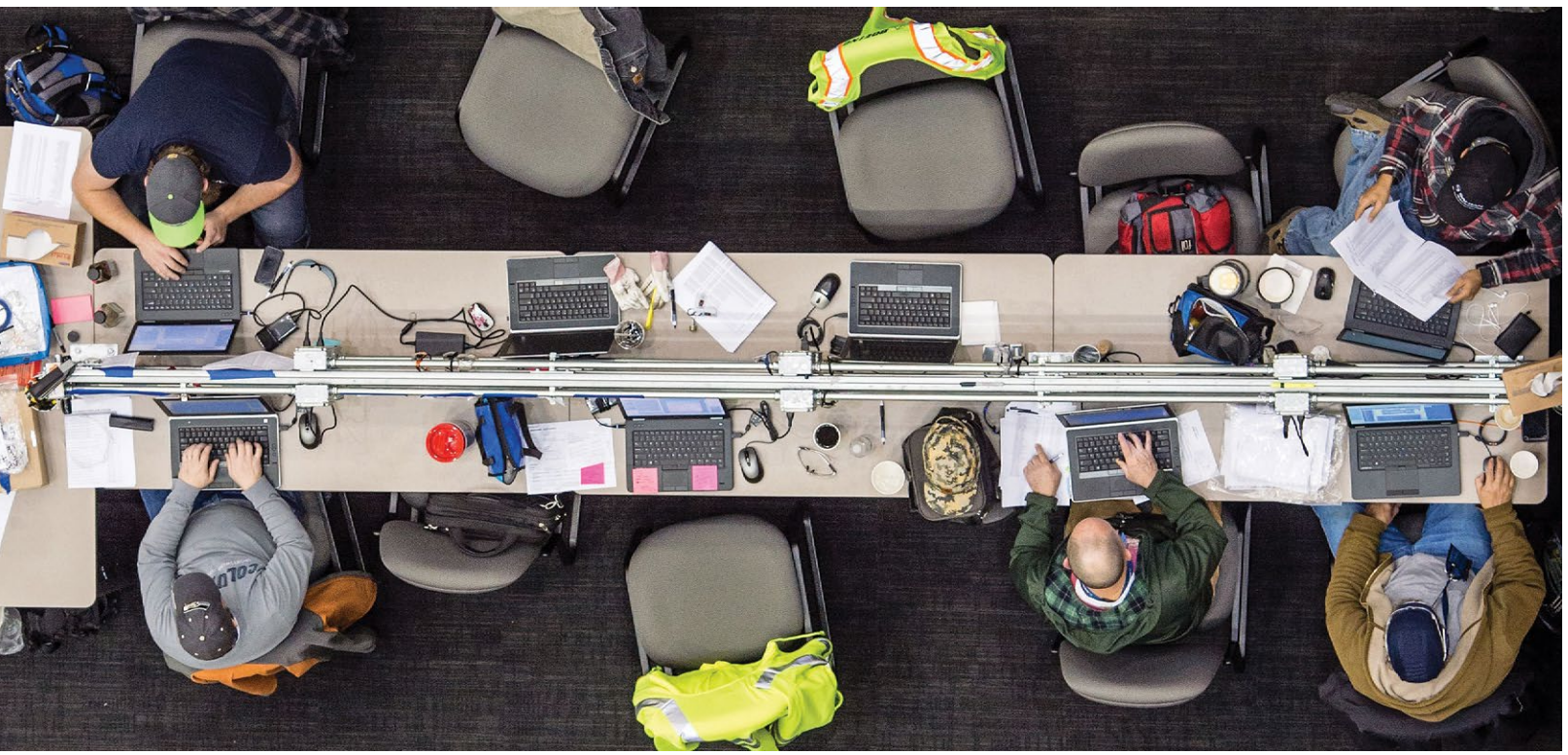
217
13



1988

Condor UAV
The Boeing-built Condor is a pioneering unmanned aerial vehicle, or UAV, built entirely of all-bonded composite materials.



[3] In Colorado, a Digital Aviation Research team runs a simulation using software Jeppesen is developing to improve disruption management for airlines.

[4] Mechanics and engineers with Boeing Test & Evaluation lend support at a temporary workstation on the Renton, Wash., factory floor as the 737 MAX is prepared for flight test.

[5] Boeing employees provide long-term maintenance and repair support for the Mk6 Chinook fleet at Royal Air Force Odiham in the United Kingdom.

1989

V-22 Osprey tiltrotor transport
The Bell Boeing V-22 Osprey's nacelles can be rotated between helicopter and turboprop airplane flight modes and the V-22 is capable of high-speed flight.

Crew members on the Boeing flight line in Mesa, Ariz., are part of a team that prepares AH-64E Apache helicopters as company and customer pilots complete flight testing prior to delivery.

1991

C-17 Globemaster III military transport
The McDonnell Douglas C-17 Globemaster III is able to fly anywhere in the world. It can land and take off from rugged airfields.

[6] Human Resources professionals consult at the Boeing Corporate Offices in Chicago.

[7] Boeing Saudi Arabia employees, at work in the Decision Support Center in Riyadh, Saudi Arabia.

1992

AH-64D Apache Longbow attack helicopter
A prototype AH-64D Apache Longbow is developed as the world's most advanced attack helicopter.

1993

International Space Station
NASA selects Boeing as the prime contractor for the International Space Station.

7

Global Services & Support employees in San Antonio help modify and refurbish the E-4B, an advanced command and control military aircraft.

1994

777 commercial transport
The Boeing 777 twinjet is the first jetliner to be 100 percent digitally designed using 3-D computer graphics.

1995

F/A-18E/F Super Hornet fighter
The Super Hornet is an advanced version of the combat-proven F/A-18 Hornet and produced in the single-seat E model and the two-seat F model.

1996

Boeing acquires Rockwell International's aerospace and defense units.

[8] Finance employees visit the F-15 line in St. Louis to observe how inventory is flowing through the factory.

[9] Simulator technicians service a 737 flight simulator at the Boeing Flight Services Campus in Singapore.

[10] In Mesa, Ariz., Boeing Security & Fire Protection performs a search and rescue exercise.

1997

McDonnell Douglas Corp. merges with Boeing.

Next-Generation 737 commercial transport

The Next-Generation Boeing 737 models build on the strengths that made the 737 the world's most successful commercial airliner, while incorporating significant improvements.

[11] In Australia, Boeing employees help sustain Royal Australian Air Force F/A-18F Super Hornets at RAAF Base Amberley.

[12] Employees at the Boeing subsidiary Aviall site in Dallas provide aviation parts and services.

2000

Boeing acquires three units of Hughes Electronics Corp., including Hughes' satellite manufacturing business.

Boeing acquires Jeppesen, the industry leader in flight planning and navigational services.

Boeing acquires Australia's Hawker de Havilland.

Working with a “One Boeing” team including Environment, Health & Safety and Site Services, employees at the Boeing Philadelphia CH-47 Chinook factory appreciate more natural light and reduced energy use through renovations such as new windows and skylights.

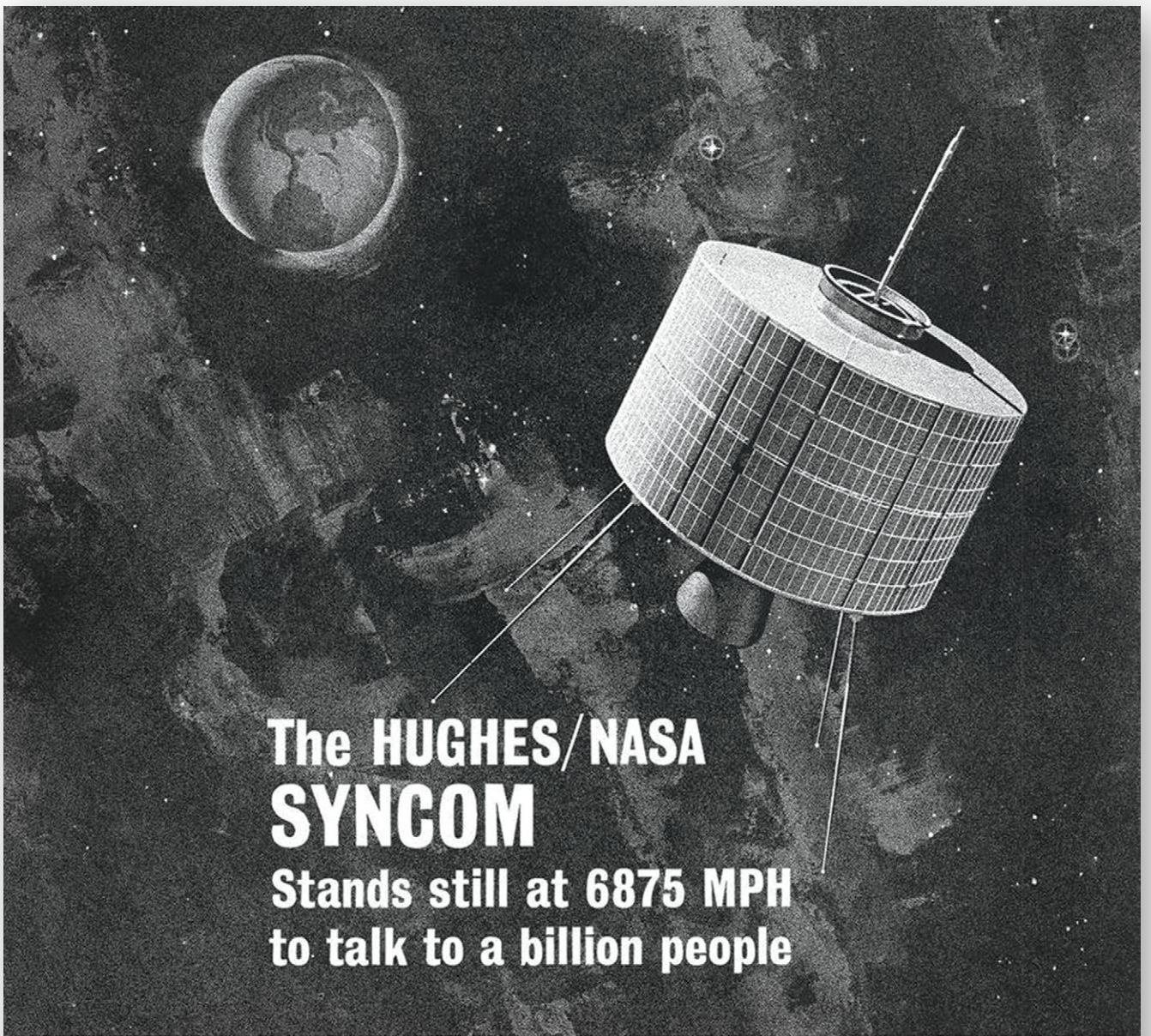
2001

Boeing headquarters is relocated to Chicago.

2002

ScanEagle UAS
Insitu's ScanEagle is a long-endurance unmanned aircraft system. Insitu would later become a wholly owned subsidiary of Boeing.

Delta IV rocket
The more powerful Delta IV rocket can accommodate single or multiple payloads on the same mission.



The HUGHES/NASA SYNCOM

Stands still at 6875 MPH to talk to a billion people

Syncom is an entirely new kind of communications satellite. It is the first synchronous satellite — the first to "stand still" in space.

Actually it is traveling 6,875 mph. But at its altitude of 22,300 miles, Syncom's speed matches the earth's rotation. Result: It is "parked" over the earth.

From this vantage, above the mouth of the Amazon River, Syncom can "see" 40% of the earth. Thus it can beam signals to over one billion people in North and South America, Western Europe and Africa.

Further, since Syncom remains in a controlled position, it can be used 24 hours a day for uninterrupted communications to this entire area.

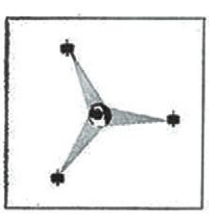
In fact, in Syncom's first month of operation, it logged more operating time than all other communications satellites had up to that time.

Little wonder NASA has called Syncom a major breakthrough in the peaceful use of outer space.

Hughes Aircraft Company, under contract to NASA, is proud to have conceived, designed and built Syncom.

◀ *Syncom differs* from other satellites in that it is precisely controlled in a high-altitude orbit. Here it can be permanently "parked," while other types of satellites are in random, low-altitude orbits.

Future Syncom system in development at Hughes requires just three operating satellites to extend telephone, telegraph, TV and wire photo service to all the populated areas of the world. ▶



Creating a new world with electronics

HUGHES

HUGHES AIRCRAFT COMPANY

Syncom

The world's first geosynchronous communications satellite, Syncom was created by a Harold Rosen–led team at Hughes Space and Communications and began a communications revolution that has had an enduring impact around the world. Syncom II was launched by Hughes, a Boeing heritage company, and NASA on July 26, 1963, and enabled the first live international phone call between two heads of state, President John F. Kennedy and Nigeria's prime minister, Abubakar Tafawa Balewa. In 1964, Syncom II and Syncom III made possible the first live TV transmission by satellite, broadcasting Tokyo's Olympic Games to the United States. ●

Dash 80

The Boeing 367-80 was a single prototype for the first U.S. commercial jetliner, the 707, as well as the first jet air-refueling tanker, the KC-135. Better known as the Dash 80, it flew for the first time on July 15, 1954, and was responsible for proving many Boeing technologies and innovations. The Dash 80 combined aerodynamic and structural features of the Boeing B-47 and B-52 jet bombers. About a year after that first flight, famed Boeing test pilot Tex Johnston drew widespread attention to the new airplane when he unexpectedly performed two barrel rolls over Seattle's Lake Washington, witnessed by a large crowd watching hydroplane races. ●

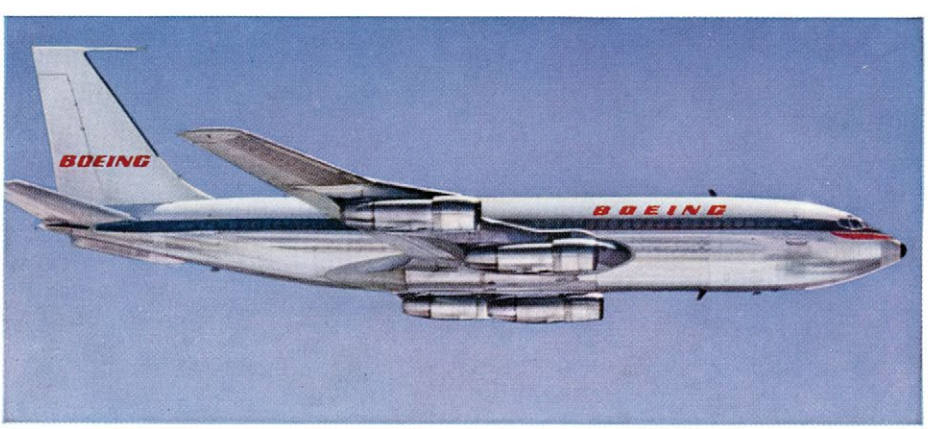
Mrs. Earl Calkins, recent "first flighter" aboard a Boeing jet, says . . .

"I stepped off fit for a shopping spree!"

"I always felt tired at the end of a long trip—until I flew in a Boeing jetliner," Mrs. Calkins reported. "My Boeing flight was so smooth and quiet I hardly realized we were moving. There was no vibration. Before I knew it, we were ready to land. The whole trip was so relaxing and restful I stepped off fit for a shopping spree. Flying on that jet was such a wonderful experience I'm looking forward to my *next* Boeing trip. From here on, it's *my* way to travel."

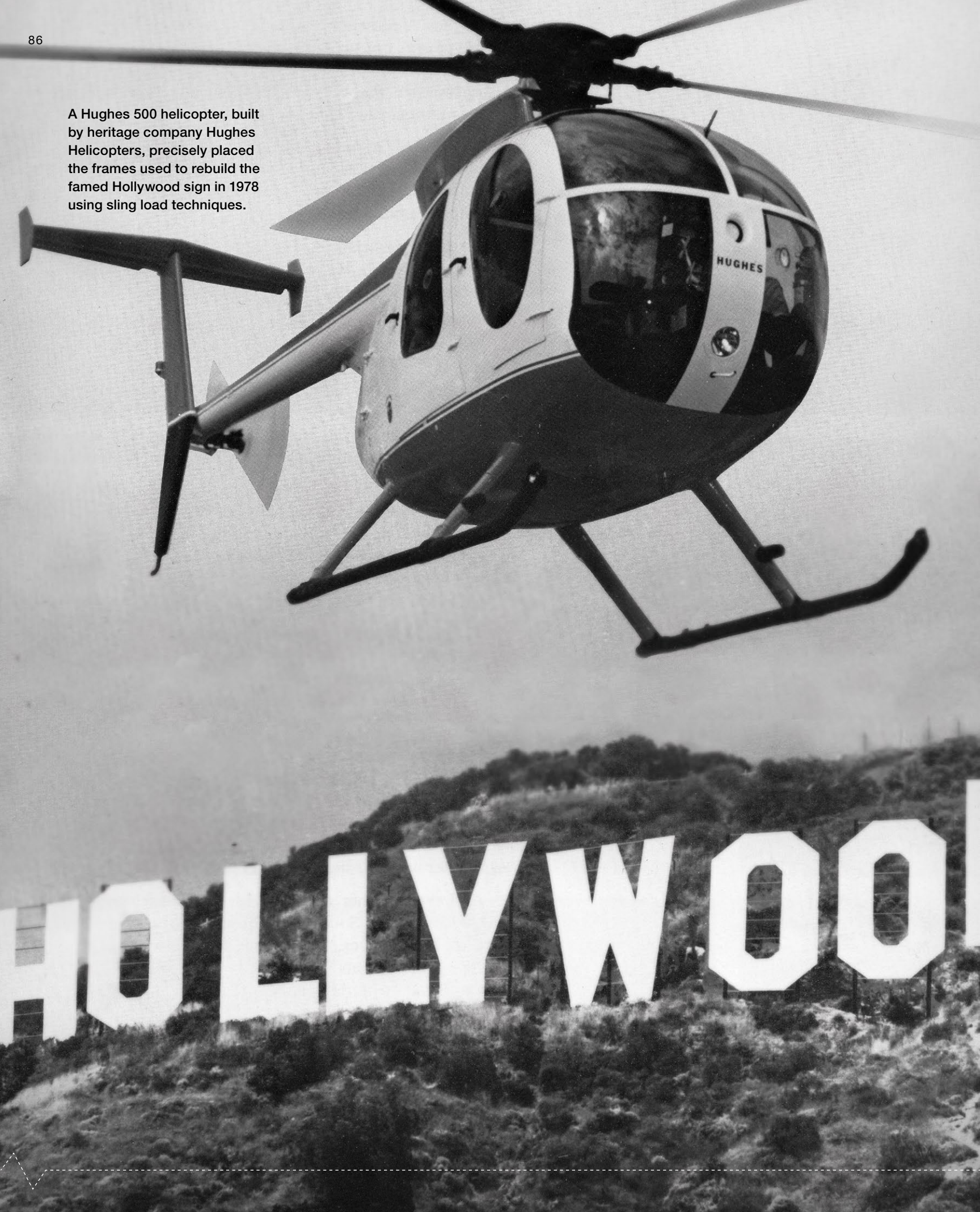
More than 6,000,000 women have already flown by Boeing jetliners. Boeing jets are the most proved, most popular jetliners in the world.

These airlines offer Boeing jetliner service: AIR FRANCE • AIR-INDIA AMERICAN • AVIANCA B.O.A.C. • BRANIFF • CONTINENTAL EASTERN • EL AL • IRISH • LUFTHANSA NORTHWEST • PAKISTAN • PAN AMERICAN QANTAS • SABENA • SOUTH AFRICAN TWA • UNITED • VARIG *and* WESTERN. *Boeing jets go into service later with:* CUNARD EAGLE • ETHIOPIAN PACIFIC NORTHERN *and* SAUDI ARABIAN.



BOEING Jetliners

LONG-RANGE 707 • MEDIUM-RANGE 720 • SHORT-RANGE 727



A Hughes 500 helicopter, built by heritage company Hughes Helicopters, precisely placed the frames used to rebuild the famed Hollywood sign in 1978 using sling load techniques.

Lights, camera, Boeing

STORY BY DAN RALEY
PHOTOGRAPHY BY BOEING | DELTA AIR LINES | GETTY

Portraying a passenger in the cabin of a DC-6, the young woman posed for photograph after photograph. She handed her coat to a flight attendant, reclined in a window seat and tested out a sleeping bunk, smiling with each click of the camera.

A Los Angeles native, married and just 19, she turned this session into her first modeling endorsement, according to the historians who have tracked her career. With a red bow fastened to her curly brown hair, she looked nothing like the pop culture icon that she would later become.

From this 1945 photo shoot for Boeing heritage company Douglas Aircraft, with World War II having come to an end, the woman at the center of attention signed her name, Norma Jeane Dougherty, to a model release form. She later became unmistakably blond and a larger-than-life presence on the big screen—reinvented as Marilyn Monroe.

Since the onset of commercial airline travel and big-budget filmmaking, Boeing and Hollywood have continually crossed storylines. Each industry has been fascinated by the other's concerted push to make the world a more magical and accessible place, whether using engine turbines or cinematic narratives.

They've shared in airplane rollouts and movie premieres. Aircraft of all kinds have appeared in nearly 5,000 films. Actors not only have been depicted as aviators, but some have brought real-life piloting skills to the flight deck, such as John Travolta and Harrison Ford.

"They have been as interested in us as we have been interested in them," said Dave Knowlen, Boeing director for Special Projects.

Marilyn Monroe's Boeing moment was one of discovery—of the world suddenly finding out about her. The DC-6 photos, which are now stored in the secure and temperature-controlled Boeing Archives in Bellevue, Wash., were taken inside a cabin prototype rather than the actual airplane. One of the images, showing Monroe surrounded by fellow passengers in neon-colored seating, ended up on the cover of the January 1946 issue of *Douglas Airview*, a publication for company employees.

This was Monroe's first magazine cover, according to her historians. Memorabilia collectors everywhere seem to agree with that, shelling out more than $2,000 in online auctions for each rare copy of the *Douglas Airview* issue, which includes a full-page advertisement featuring Monroe and others interacting with a flight attendant.

The ready connection between Hollywood and Boeing is not lost on Casey Sander, a veteran character actor who lives in Los Angeles. He's appeared in several feature films and more than 300 TV episodes, among them *Grey's Anatomy*, *Mad Men*, *Grace Under Fire* and *Home Improvement*. His father worked for Boeing. His cousin is currently a Boeing machinist. He understands the overlap of filmmaking and aviation, one fueled by the common need for diversion and fun.

"Hollywood is escapism and going on a Boeing airplane is escapism—it's a dream," Sander said. "When you escape into a 60-foot darkened room or inside an airplane, your bad day goes away."

Douglas Aircraft, located in the Los Angeles area not far from the film studios, was one of the first aerospace companies to interact with Hollywood headliners with its airplanes. A-listers such as Clark Gable, Carole Lombard, Gary Cooper, Hedy Lamarr, John Wayne and Shirley Temple were among those photographed

2003

777-300ER commercial transport
The 777-300ER (Extended Range) is the world's largest long-range, twin-engine jetliner.

with Douglas airplanes while touring, celebrating or even christening the various new models coming off the production lines at the Santa Monica and Long Beach plants in California.

The outbreak of World War II only served to strengthen the bond between the film world and Boeing. Bond rallies and drives brought them together on a regular basis as fighting raged overseas. In 1943, actor and comedian Bob Hope even rode a tank into a Sunday night event attended by 40,000 people at a Seattle football stadium, with his entrance used to promote the recruitment of workers, especially women, to build Boeing's B-17 bomber.

As modern moviemaking demanded more and more aviation themes, airplanes and facilities for Boeing and its heritage companies popped up in a steady stream of popular releases, among them *Airplane!*, *Airport*, *Air Force One*, *Apollo 13*, *Behind Enemy Lines*, *Black Hawk Down*, *Bullitt*, *Catch Me If You Can*, *Executive Decision*, *Godzilla*, *Independence Day*, *Mission Impossible*, *Snakes on a Plane*, *Speed*, *Starship Troopers*, *The Right Stuff* and *Top Gun*.

"One of my favorite movies is *Top Gun*, which brought together the idea of flight, the romance of that particular character and the power of jets," said Sander, referring to the Tom Cruise film that involved the heritage Douglas A-4 and TA-4 Skyhawk aggressors amid a variety of aircraft. "That movie did a lot for aviation."

The Boeing name has appeared numerous times on screen. *Boeing, Boeing* was a comedic film featuring Jerry Lewis and Tony Curtis. A television episode for *The A-Team* was titled "The Beast from the Belly of a Boeing." And in the film *Airport*, an airline pilot played by actor Barry Nelson uttered the following line after his crippled 707 landed safely with a huge hole in its fuselage caused by a bomb blast: "Remind me to send a thank-you note to Mr. Boeing."

Scenes for *Apollo 13*, *Species*, *Puppet Master* and *Austin Powers* were filmed at Boeing's Seal Beach, Calif., facility, used to build Global Positioning System satellites, among other products. Different rooms offered unique settings favored by the Hollywood set.

"It looked spacey in there with all the clean rooms," said Erik Simonsen, a former Boeing employee and witness to the proceedings. "Ron Howard and Tom Hanks used my wife's office."

Space Cowboys, starring Clint Eastwood, was filmed at a Boeing facility in Downey, Calif., since closed. A small town was built and flooded by a water tank for the film *Hard Rain*, featuring Morgan Freeman and Christian Slater, inside a Boeing facility in Palmdale, Calif., once used to produce the B-1B Lancer bomber.

Richard Karn is a longtime TV actor, known best for his role as "Big Al" in *Home Improvement* and the host of *Family Feud*. He grew up around Boeing in Seattle. His sister worked for Boeing in Kansas. He fully comprehends the Hollywood attraction to airplanes.

His *Home Improvement* co-star, Tim Allen, owned a Gulfstream business jet. Karn has spoken at length about aviation with fellow actor Kurt Russell, who earned a private pilot's license in recent years. Karn and others in Hollywood have watched in wonder as actor John Travolta increasingly has fueled his passion for flying—by owning and receiving a type rating to fly a 707-138B, which he keeps outside his Florida residence.

"He's really kind of moved his life around to have that airplane in his world, living in a place with a parking spot for it," Karn said of Travolta. "It's very important to him. He gets a big kick out of having that plane, but he's also done a lot of humanitarian things with it."

Travolta, who has attended several Boeing events and rollouts, was trained to fly the 707 and 747 on company

Norma Jeane Dougherty, later known as Marilyn Monroe, appeared on her first magazine cover after this 1945 advertising shoot in a Douglas DC-6 cabin mock-up.

2006

Boeing acquires Aviall, the largest independent provider of new aviation parts and services in the aerospace industry.

CH-47F Chinook helicopter
The first production CH-47F Chinook is a multi-mission, heavy-lift transport helicopter.

2007

X-48B
The Boeing X-48B unmanned research aircraft features a Blended Wing Body, possibly the shape of airplanes to come.

[1] John Travolta, a licensed and type-rated pilot, arrives in his personal Boeing 707.

[2] Aviation pioneer and Hollywood movie mogul Howard Hughes with his H-1 Racer.

[3] Elizabeth Taylor strikes a pose in front of a Delta DC-6.

simulators, according to Knowlen, Boeing's director of the Special Projects team. Travolta is not the only Hollywood star who has been exposed to Boeing's inner workings, either.

Actor Gene Hackman, when he was involved in auto-racing pursuits, toured Boeing wind-tunnel testing facilities and was offered technology tips that would help improve the performance of his racing cars.

Director Steven Spielberg and

2009

P-8A Poseidon maritime patrol aircraft
The P-8A Poseidon is a multi-mission maritime aircraft and derivative of the 737-800.

787 Dreamliner commercial transport
The 787 Dreamliner is an advanced airplane representing the first major use of composite structures in large commercial airplanes.

2

3

actor Tom Hanks were among those who attended a special event for HBO's *Band of Brothers* miniseries, held in Boeing's flight-test hangar in Seattle. They were cognizant of their surroundings. Both Hollywood VIPs rushed outside to catch a glimpse once they heard engines start up for the iconic Boeing Model 307 Stratoliner, offering its distinctive and historical sound, Knowlen said.

Actor Ford was saluted at a luncheon in his honor in Seattle, for his help in producing a film for the Museum of Flight. Boeing presented him with a leather jacket, which seemed apropos for the man who made the *Indiana Jones* film series a lasting part of pop culture. A private pilot, Ford was in his element amid people who build airplanes for a living.

"I found him asking more questions pertaining to aviation milestones than anyone would ask him about his life and film career," Knowlen said. "I've found actors no different than anyone I work with—they have a fascination for aviation and a certain awe with Boeing." ●

2010

747-8 Freighter
The Boeing 747-8 Freighter achieves a maximum takeoff weight of more than 1 million pounds (450 metric tons)—the first Boeing airplane to do so.

Boeing acquires Argon ST, advancing the company's capabilities in the command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR) markets.

Mercury, Gemini and Apollo

These three spacecraft built by Boeing heritage companies answered President John F. Kennedy's challenge to the country to land U.S. astronauts on the moon before the end of the 1960s. On Feb. 20, 1962, John Glenn became the first American to orbit Earth, in a Mercury capsule built by McDonnell. The two-person Gemini spacecraft, also built by McDonnell, followed. North American built the three-person Apollo spacecraft used for the actual missions to the moon and back. Meanwhile, Boeing, North American and McDonnell Douglas built all three stages of the Saturn V rocket, which was 363 feet (111 meters) long and hurled the Apollo spacecraft into orbit and toward the moon. And Boeing built the Lunar Rover that carried astronauts across the moon's surface, vastly increasing the amount of area they could explore. ●

John Tracy, Boeing chief technology officer, considers Boeing's next 100 years and what they might bring.

Leaps of imagination

STORY BY JAMES WALLACE
PHOTOGRAPHY BY BOB FERGUSON

A glimpse of the future can be seen just outside the office of John Tracy at Boeing's corporte headquarters in Chicago. Four paintings by Boeing artists depict human space colonies on the moon and Mars. Next to the paintings is a placard with these words of explanation:

"Though many of these far-reaching ideas have yet to materialize, the renderings represent the imaginative scope that has made space exploration possible."

Tracy, who retires this month after 10 years as chief technology officer and a Boeing career that spanned more than 35 years, has little doubt such colonies will come to pass, possibly during the company's second century, which begins July 15. After all, it didn't take all that long to go from flying in crude airplanes to walking on the moon during Boeing's first century.

That 100-year legacy of Boeing innovation—of daring to dream big, of having the courage and confidence to take risks, of doing what many thought impossible—began just a few years after the Wright brothers made history's first powered manned flight in 1903 over the wind-swept sand dunes of Kitty Hawk in North Carolina. The length of that flight, 120 feet (36.6 meters), would have fit inside the main cabin of the first 747, with plenty of room to spare. But those 12 seconds changed the world forever. It would take only 66 years until astronauts Neil Armstrong and Buzz Aldrin were bounding across the Sea of Tranquility in July 1969.

And Boeing's next 100 years, what will they bring? What new frontiers will be crossed? When will humans leave footprints across the Martian landscape? What leaps of imagination will give wing to aerospace advances that change the world—and possibly above and far beyond it?

"Many people say we will get to Mars by 2030 or 2040. And I absolutely believe that," Tracy said during a discussion about Boeing's past and its future, and the leaps of imagination and march of innovation that will connect the two. "I don't think we will have colonies on Mars by then, but we will certainly have a presence."

And it's a good bet that Boeing will help make it happen—and so much more, according to Tracy. Proof is in the photographs on Tracy's office walls and in the models on his desk and shelf, innovative and industry-changing products from Boeing and its heritage companies that have left huge footprints in aerospace during the company's first 100 years: the hypersonic X-15 research vehicle, which set speed and altitude records that still stand today, and which rocketed its pilots to the edge of space to gather data critical for the U.S. manned space program that followed; a night launch of one of the space shuttles, a reusable space plane that was boosted

"Many people say we will get to Mars by 2030 or 2040. And I absolutely believe that."

2011

747-8 Intercontinental commercial transport
The 747-8 Intercontinental provides 467 seats in a three-class configuration.

2012

Space Launch System
Boeing begins initial design of the core stage propulsion system and production line, as well as avionics, for NASA's massive, new heavy-lift launch vehicle that will carry crew and cargo beyond Earth.

into orbit with powerful rockets and engines but which returned to Earth like a glider; the 787 Dreamliner on its first flight in December 2009, the first large commercial jetliner with a mostly composite skin instead of aluminum, bringing more comfort for passengers and efficiency for airlines.

That legacy of accomplishing such great things, according to Tracy, would not be possible without an environment where innovation can flourish, where ideas can take flight, where it is OK to fail. And that's what will drive Boeing's accomplishments during the next 100 years, he said.

"You have to have an environment that encourages people to try new things and where it is OK if something doesn't work out," Tracy said. "And the faster you find out if it's not going to work out, the better you are. And the person should not feel like it's anything bad for them if one of their ideas doesn't work out."

There is no picture in Tracy's office of Dick Fosbury, but perhaps there should be; Tracy mentioned him several times when talking about innovation and how it will drive Boeing's success during its second century. Fosbury would eventually become a civil engineer, but his most historic achievement came in track and field. He was a high jumper, and a very ordinary one, until the day he tried flinging himself over the bar backward. At the time, high jumpers mainly used two different techniques: the scissors jump, where the athlete threw first one leg and then the other over the bar, and a variant known as the western roll, where the athlete went over the bar facedown.

Fosbury kept perfecting his technique, which became known as the Fosbury Flop, and in 1968 he won the Olympic gold medal in high jumping, besting the Olympic record.

"Everybody jumps that way now," Tracy said. "He was able to do something that changed the high-jumping world. But I'm sure that the first day he tried it, it was underwhelming. Sometimes big ideas need time to flourish."

And Boeing, too, will continue to do great things during its next 100 years, he added. "But you have to have a place where it is safe to innovate and where the established culture and practices and processes won't squeeze the life out of new ideas."

Boeing aspires to create that kind of culture—and it has, Tracy said, through various organizations such as Phantom Works, the Product Development group within Commercial Airplanes, and Boeing Research & Technology.

He also noted that Boeing has three "bins" of things its engineers are working on. These are known as Horizon 1, Horizon 2 and Horizon 3. It's important that Boeing invest in all three, or "across the spectrum," Tracy said. It could be investing in MEMs, or micromechanical machines that print out one atom at a time to make a device on the molecular scale to perform some function, or it could be how to put paint on the next 777X better, Tracy said.

"Because you don't know what the next big thing is, you have to have a portfolio approach where you are investing in a lot of these things," he said.

In the first bin, Horizon 1, are technologies Boeing is working on about six months out, technologies that can affect products that are in production now, or improve the company's factories, Tracy explained. The Horizon 2 bins are a little further out.

And Horizon 3? That's the "far-out" stuff, Tracy explained. "These are technologies we're working on that we think could be disruptive, that could radically change our way of business. It could put us out of business; it could put us in a new business."

Tracy said Horizon 3 is typically "the stuff that somebody in a business unit could view as a waste of time because they can't see a direct link between it and their business. It's the innovator's dilemma. The people with an established business have certain things they want you to work on that are key to their business success as they see it. But there are other needs that they aren't even thinking about that could put them out of business, and we have to be looking at those."

"You have to have an environment that encourages people to try new things and where it is OK if something doesn't work out."

A classic case of a disruptive technology was tiny computer hard drives, he said. "One day, someone asked, 'What if we could make a hard drive that was only a one-inch square. What could you do with that?' And out of that was born the iPod." But another group of companies at the time were making CD changers, Tracy said, and they were wondering how they could fit more CDs into their CD changers. What happened? "They are out of business. Gone," Tracy said. "And all because when they were asking for a better CD changer someone came along with this tiny hard drive. And that's what we have to worry about. We must

2014

CST-100 Starliner spacecraft
NASA selects Boeing's Crew Space Transportation vehicle, known as the CST-100 Starliner, as the next U.S. spacecraft system to carry astronauts to and from the International Space Station.

make sure that we are never caught by surprise by somebody coming along with something like a cold fusion energy system and you no longer need airplane gas turbines."

As for predicting what will happen during the next 100 years, that's difficult, Tracy said. Who knows what the "next big thing" might be that will change the world, much as computers have.

Tracy recalled that when he started at Boeing as a stress analyst with McDonnell Douglas in 1981, at Huntington Beach, Calif., his job was plotting test data—by hand. There were no personal computers.

"I remember the first time they brought a personal computer into our work area that could plot that same data in seconds," he said. "It dramatically changed how much time an engineer spent doing engineering versus clerical work. The problems that we are able to solve today analytically, using computers, would have been unfathomable back then. And we are far from where computer technology is heading."

So what will be the next big thing that could radically change technology and the world? That's still to be determined, since scientists continue to make discoveries and envision ways to turn these findings into life-changing innovations, Tracy said. He noted, for example, how the discovery of radio waves changed the world.

Radio waves were first predicted in 1867 by Scottish mathematical physicist James Maxwell. His mathematical theory, now called Maxwell's equations, described light waves and radio waves as waves of electromagnetism that travel in space. About 20 years later, Heinrich Hertz demonstrated the reality of Maxwell's electromagnetic waves by generating radio waves in his laboratory.

"In less than 150 years," Tracy said, "we went from not even knowing that radio waves existed to today, where you can be on your cellphone and calling home from anyplace in the world."

"Is it going to be like radio waves, where one day someone will figure out how to leverage it (recently detected gravity waves) into things we've never even dreamed of? We are only on the cusp figuring out how we can actually use this to do beneficial things."

The world, he added, could change as much, and perhaps even more, in the next 100 years, as it has since Bill Boeing made his first seaplane, the B&W, on the shores of Seattle's Lake Union.

"We're still learning about basic science and physics," he said. "As we learn more, that will lead to inventions that will change the world."

One example of how we continue to learn more about basic physics was the recent announcement by scientists that they had, for the first time, detected gravitational waves, which had been predicted 100 years earlier by Albert Einstein.

"Is it going to be like radio waves, where one day someone will figure out how to leverage it into things we've never even dreamed of?" Tracy asked. "We are only on the cusp of figuring out how we can actually use this to do beneficial things."

So what will The Boeing Company of 2116, and the world, look like? Space will be a huge component of that future, Tracy predicted.

"Boeing will be moving people from Earth's surface back and forth to space. We will be in the space habitat business," he said. "We are in the space habitat business today. We are the ones who built much of the International Space Station. And we also built the space shuttles. Nobody has more experience in this area than us. And I've got to believe that as long as we are not arrogant, and as long as we are not too bureaucratic when it comes to investigating new ideas, we will continue our leadership in the movement of people where they want to go. That's going to be on the surface of Earth to go see your mother or your father in a different city, but it's also going to be into space if they're living in space—or if you just want to go there."

But getting there, Tracy added, will require the leaps of imagination and innovation that played an essential role in charting the course these past 100 years, of daring to dream big and then turning those dreams into reality.

"Our biggest challenge," he said, "is creating a fertile environment where people feel safe coming up with ideas that are different, and not having a system that instantly says 'no,' because they have never seen somebody do the high jump that way before … that just can't be the right way to do it." ●

2015

KC-46A Pegasus military tanker

Based on the Boeing 767 commercial jetliner, the KC-46 tanker is a widebody, multi-mission aircraft with the latest advanced technology.

2016

737 MAX commercial transport

The 737 MAX 8, a redesign of the legendary 737, is the first member of Boeing's new family of single-aisle, fuel-efficient airplanes.

MADE WITH PRIDE BY THE EMPLOYEES OF BOEING