

IQ INNOVATION

QUARTERLY

INNOVATION, INSIGHT, INSIDE AEROSPACE

Top Shelf Engineer

From B-52s to bookshelves, Ashley Basnight brings a lot to the table

Six Feet Apart

Aerospace manufacturing in a COVID-19 world

Virtually Overnight

Ensuring cybersecurity when work goes home

Confident Travel

Technology is key to passenger return

PLUS: How the world's aerospace leader pivots in a pandemic

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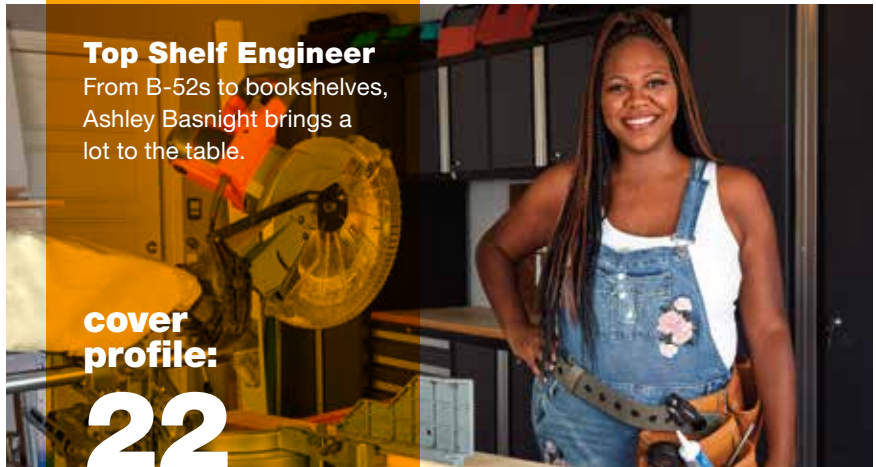
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Top Shelf Engineer

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lot to the table.

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Opportunity in adversity

We will not soon forget 2020. We have experienced adversity and momentous change. But daunting challenges offer opportunity — opportunity to innovate, pitch in, come together and overcome what seem like insurmountable obstacles.

Transforming adversity into opportunity appears on almost every page of this edition of Innovation Quarterly.

As people around the world join together to support each other during this pandemic, we at Boeing rally to reinforce our communities too.

As many of our teams made the monumental move to work from home, we innovated to sustain their health and well-being. For those needed on-site, we put in place effective measures to resume manufacturing aircraft and spacecraft while committing to employee safety.

We worked with partners throughout the aerospace industry to be a leader in the global effort to provide passengers and crew a healthy and efficient travel experience so we can all safely and confidently return to the skies.

We share stories of engineers like B-52 software engineer Ashley Basnight, whose quest for the perfect table led her to make it herself.

We also deepened our reservoir of technical leadership with the induction of a dozen new Senior Technical Fellows and three Principal Senior Technical Fellows.

Our archivists even uncovered a Boeing memo sent during the 1918 pandemic that reassures us we've been down this road before and made it back.

So yes, we've been through a lot. And the journey's not nearly over. 2020 will change all of us. But we can all change the world too. Opportunity awaits. **IQ**

A handwritten signature in blue ink that reads "Greg Hyslop". The signature is stylized and fluid.

Greg Hyslop
Chief Engineer



A LIFESAVER

A container of lifesaving personal protective equipment is unloaded from a Boeing Dreamlifter following a COVID-19 response airlift mission.

Supporting our communities in a crisis

Boeing's COVID-19 response

In a matter of weeks, a global aerospace company pivoted to fight a pandemic:

- **Activating our additive manufacturing network to produce urgently needed face shields.**
- **Leveraging our transportation capabilities to transport millions of pieces of personal protective equipment (PPE).**
- **Empowering employees to help through donations and volunteerism.**
- **Donating supplies to front-line health care workers and local communities.**
- **Collaborating with partners throughout the industry to support communities around the globe.**

Here's how.

As COVID-19 began spreading around the world, numerous companies, including Boeing, pivoted their operations to help in the effort against the pandemic. How that came about is a case study in taking collective action, developing innovative solutions, and adapting business to deliver what customers and communities need.

This is a behind-the-scenes look at what we did at Boeing, how we evaluated opportunities and the actions all of us at Boeing took to support communities fighting COVID-19.

Getting started

As the reality of the coronavirus outbreak became evident, Boeing's immediate priority was ensuring the health and safety of our workforce as well as the well-being of our suppliers, partners and customers.

At the same time, we recognized that we could help our communities in the fight against COVID-19.

Inquiries and information poured in from employees, media, external stakeholders, partners and customers around the globe.

The compassion was inspiring, but we needed to focus and direct our energy so that we could apply Boeing's unique expertise, capabilities and resources to help most effectively.

We quickly launched a "How Boeing Can Help" campaign on an internal problem-solving innovation platform so that individuals and teams throughout the company could raise ideas and opportunities and collaborate toward solutions. For years we have used this platform for tapping into the creativity and expertise of teammates throughout Boeing in order to solve technical challenges, such as developing more aerodynamic surfaces for specific product use cases.

Now we dedicated it to capturing and distilling valuable employee knowledge and ideas into specific actions Boeing could take to fight COVID-19. Boeing employees were quick to stand up and help in the effort. Thousands of our employees from more than 100 locations in 13 countries shared ideas and information.

We consolidated and solidified our focus areas toward what was feasible and most in demand, beginning with the urgent need for PPE among local hospitals and health care providers. We assessed requests and opportunities to use our machining capabilities, ways to apply advanced technologies, and offers and asks from suppliers.

We sought to develop solutions at scale that could be delivered in multiple local executions and that would meet local requirements and needs. Ideas that required extensive engineering outside our core competencies — or medical-grade certifications — were best left to experts in those fields. We sought to fill gaps we could quickly add value on and those where Boeing might be especially needed. We analyzed real-time needs as the shortages and challenges evolved.

From ideas to action

Thanks to that outpouring of ideas and the concerted efforts of thousands of employees, Boeing has been able to provide relief assistance to communities around the world.

What we did:

Manufacturing face shields

To make face shields, we quickly developed a fabrication and assembly plan that leveraged our additive manufacturing capabilities and other tooling. With health care personnel confronting PPE shortages, we were able to address an immediate critical need with 3D printing. Our Boeing Additive Manufacturing teams validated design and supply chain requirements and secured donations from suppliers for the clear plastic and adjustable head bands that connect to the 3D-printed frame.

We manufactured more than 40,000 face shields and donated them to the Federal Emergency Management Agency and other organizations for distribution.

Airlifting medical supplies and PPE

We recognized that we had a unique capability to airlift crucially needed PPE to help front-line health care workers and first responders. Shipping irregular cargo is one of our core competencies, so we knew we could make a difference, especially as many cargo carrier flights were backlogged at the time due to the emergent crisis.

In order to coordinate these deliveries, our organizational connections and partnerships with external partners, including state and national government entities, were crucial. Through numerous PPE airlift missions, our Dreamlifter fleet and other company-owned aircraft delivered more than 4.5 million pieces of lifesaving PPE to support those on the front lines of fighting COVID-19.

Connecting the global supply chain

We were able to connect suppliers and industry partners to facilitate the success of COVID-19 response efforts. For example, we received a request from a Seattle hospital that was launching a mask manufacturing project. The hospital had received a large batch of material from Asia but needed a partner to help with fabrication.

Within days, we were able to connect the hospital with a supplier to partner on cutting fabric, and the project kicked off successfully.

Volunteering and donations

From the very beginning of the COVID-19 challenge, Boeing employees wanted to help. Our employees donated more than \$1.5 million to community COVID-19 response.



IN SHORT SUPPLY

Boeing engineer Jared Tompkinson examines one of the tens of thousands of face shields that the company additively manufactured to provide immediate relief to health care workers facing critical PPE shortages.

PHOTO: BOB FERGUSON

Along with corporate support through the Boeing Gift Match Program, which matches employee financial donations, Boeing has also provided guidance for safe volunteering and resources to help Boeing employees make a difference with their personal philanthropy.

For example, we collaborated with a ventilator producer that needed electrical and mechanical engineering support in order to increase production. We identified Boeing employees qualified with the right technical skill sets who were willing to volunteer, expediting the ventilator company's expanded efforts.

And as a company, we have donated more than 225,000 pieces of PPE, along with numerous STEM learning and educational supplies.

Coordinating with partners

Throughout this effort, we joined with coalitions of federal agencies, aerospace and medical associations, and health care organizations to share information and explore opportunities for collaboration.

These partnerships were an excellent source of real-time information about estimated PPE needs, compliance, FDA rules and more.

Confident travel

Our work to fight this pandemic continues. Now, a major focus is the Confident Travel Initiative. We are partnering with airlines, regulators, and medical specialist and industry organizations around the world to inform

passengers and crew about existing protective systems and additional efforts to enhance the safety of air travel.

As 2020 started, no one at Boeing had the job title "pandemic response coordinator." We had emergency operations and continuity planning functions and a health and medical staff, but not a "global disease outbreak" function. Boeing was like almost all other companies in the world — we had to figure it out in real time.

Today, coronavirus response is a part of everyone's job. How we work has changed. Change is hard in any context — this change has been harrowing and heartbreaking. But we are learning from the rapid response to this crisis as we continue to support communities at this time of great need and shape the future together. **IQ**

About the author:

Amy Bann, who supports Boeing's sustainability, strategy and corporate development efforts, was one of the many team members who contributed to Boeing's COVID-19 relief strategy.



PHOTO: RUBY SOMERA



COVID-19 RESPONSE AIRLIFT

Three Dreamlifters transported face shields and other PPE to support front-line health care professionals in South Carolina in May 2020.

PHOTO: MICHAEL WISER

Boeing's Foresight and Technology Intelligence Community of Practice tracks innovation around the world.

tech

R.A.D.A.R.

Recognizing Advanced Developments and Research



Pegasus Patient Evacuation

McConnell Air Force Base, Kan.

In July, the KC-46A Pegasus completed its first aeromedical evacuation mission, proving the aircraft's capability to sustain patient care over a 14-hour span.



Rocket Renovation

Orlando, Fla.

A new rotating detonation rocket propulsion system developed by University of Central Florida engineers improves rocket efficiency compared to traditional rocket propulsion.



Mold Eats Radiation

Durham, N.C.

Students participating in Higher Orbits, a nonprofit that inspires STEM learning through experiments in space, have found that radiation-eating fungi from Chernobyl block radiation in a test on the International Space Station.



Elephant Fingers

Adelphi, Md.

U.S. Army researchers are working on low-frequency seismic sensors inspired by elephant fingertips and similar vibration-sensing cells in other mammals.



Cleaner and Quieter Flight

Abu Dhabi, United Arab Emirates

In late summer 2020, Boeing and Etihad Airways teamed up to use a 787-10 Dreamliner to test ways to reduce emissions and noise as part of the aerospace company's ecoDemonstrator program.



Universities of Plantricity

Tel Aviv, Israel, and Tempe, Ariz.

Scientists from Tel Aviv University and Arizona State University have redirected electrons from photosynthesis in algae to produce hydrogen. The process could be a potential pathway to producing electricity from plants.



Virtual Farnborough

Farnborough, U.K.

As part of the first-ever virtual 2020 Farnborough International Airshow, a panel of airlines, industry, government and regulators discussed the recovery of commercial aviation, highlighting the multilayered approach to enhancing safety.

Innovating for safe operations and a healthy workforce

Care, concern and innovating for a 'new normal.'

BY PEREGRIN SPIELHOLZ,
BOEING ENVIRONMENT, HEALTH & SAFETY

As COVID-19 spread through our communities, we realized the increasing urgency to develop effective measures to help our sites resume operations while keeping our employees safe.

In February, COVID-19 was a focus for our operations in China and across Asia, but by March it had become a pandemic. The speed at which the virus spread was staggering as we faced a global crisis impacting many of our manufacturing facilities and offices around the world.

The day that stands out for me is March 23, 2020 — the day we suspended production at our Washington state sites, including our Everett factory, the world's largest building, where we manufacture four different airplane models. When I saw that enormous facility pausing operations, it drove home the magnitude of the situation and the challenges facing the world and us.

I was also critically aware of the impact to our employees.

As the coronavirus spread through our communities, we realized the increasing urgency to develop effective measures to help our sites resume operations while keeping our employees safe.

Based on guidance from the U.S. Centers for Disease Control and Prevention (CDC) and the U.S. Occupational Safety and Health Administration (OSHA), state rules, and Boeing's existing hierarchy of controls approach, we developed a multifaceted return-to-operations plan and implemented it across all U.S. sites. We also provided on-site managers with information to use for initial training and when checking in with employees each day about their concerns, questions and recommendations.

PHOTO: JOSH DRAKE

MASK UP

Nelson Akwari, a 787 operations superintendent at Boeing South Carolina, wears a mask to protect himself and others. The company provided face masks to all employees.

Key workplace controls included:



Eliminating exposure, where possible. Much of our workforce began telecommuting, which limits the number of employees in the workplace who might unknowingly be infected with COVID-19. It also allows us to concentrate our time and efforts on fewer work areas in order to provide a safe environment.



Engineering and designing out exposure. We took steps to increase physical distancing by staggering work shifts, resequencing work, rearranging workstations and minimizing usage of common areas. In addition, in some instances we have “paired” or “podded” work teams to minimize exposure if an employee comes to work unknowingly infected with COVID-19.



Requiring face coverings and other personal protective equipment (PPE). At our U.S. sites, we require that all employees, visitors, contractors and suppliers wear face coverings at all times while on company property, unless alone in a closed-door space or when eating and drinking. We require procedural masks for employees who are not able to maintain physical distancing for extended durations, and we require respiratory protection for specific jobs. We provide other PPE, such as gloves, when necessary based on the work task.



Implementing enhanced cleaning. While factory operations at some sites were paused, more than 15 million square feet (1.4 million square meters) — or more than five times all the office space in New York’s 102-story Empire State Building — received enhanced cleaning. On top of that, more than 1,500 restrooms received a deep cleaning. Enhanced cleaning and direct-response disinfection were implemented before start-up and continue, along with additional protocols that have been developed.



Developing cleaning and disinfection protocols for the company. We carefully reviewed CDC, OSHA, and U.S. Environmental Protection Agency (EPA) guidance. We evaluated a wide range of disinfection methods, including different chemicals, UV lights and others, and methods of chemical application (e.g., sprayers and misters). Our protocols also had to take into account the complexity of cleaning and disinfecting a wide variety of areas, including airplane interiors, sensitive electronics and airplane parts.



Cleaning individual and team work areas. We borrowed a Lean 5S best practice where employees were asked to “clean as you go” during their workdays and at the end of shifts.



Developing administrative controls. Among other actions, we implemented symptom screening protocols for employees to do a self-check for COVID-19 symptoms each day. These protocols are key to ensuring that employees ill with COVID-19 symptoms do not come in to the workplace. We have reinforced the symptom screening with signage at many of our sites.



Quarantine and contact tracing. To limit the spread of COVID-19 in our workforce and our communities, we have developed a robust quarantine and contact tracing program. If an employee has been tested for COVID-19 due to illness or has tested positive for COVID-19, the employee will be directed to remain off-site and placed on company-issued quarantine for up to 14 days. We also perform contact tracing to identify employees who might have been exposed to the ill employee; those close contacts are also placed on a company-issued quarantine.



Supporting preventive behaviors. Individual behaviors are crucial to keeping ourselves and others healthy and stopping the spread of COVID-19. (“Wear a mask and wash your hands.”) We have provided education and training resources for our employees and teams to help them understand how they can best protect themselves and each other.



Hand washing. To support our teammates in demonstrating safe behaviors while on site, we installed 600 hand-washing and 742 hand sanitizer stations at key locations throughout our facilities.

From the start of the pandemic, our aim has been to maintain the safety and health of employees, contractors, suppliers and visitors to Boeing sites. As conditions evolved, we continually integrated new safety, health, medical and epidemiological information, as well as new public health guidance, into our strategy. The key elements of our plan have been benchmarked against other companies to help us, and them, improve our COVID-19 response plans.

Our work is not complete, however. We must continue evolving with the situation. By partnering with and learning from other companies and experts worldwide, we can all benefit from innovating for safe operations and a healthy workforce. **IQ**

From the start of our pandemic response, a goal of caring for each other has been essential. We exhibit safe behaviors when we are mindful, present and ready to be at work with our whole self.

Training materials and processes reinforce the “check-in” process with managers and their teams that we had even prior to the COVID-19 pandemic. These check-ins are not a “check the box” activity but are really focused on meaningful understanding of how people are doing and feeling in body and in mind. As part of these check-ins, participants discuss their perspectives, opinions and concerns.

By encouraging employee engagement through personal, relevant and important conversations, we enhance our safety culture, because how teammates feel each day impacts their choices and decisions. Caring for each other as people is how we all best avoid incidents and injuries — now and when the pandemic is over.

Facilities throughout Boeing have received enhanced cleaning of high-touch surfaces and common areas as part of the comprehensive measures implemented for safe operations and a healthy workforce.

Inside Information: Q&A with Dan Freeman

WAND AT WORK

Boeing engineers, like Kevin Callahan (pictured), leveraged UV technology to counter COVID-19.

Dan Freeman knows what goes on inside an airplane. So when COVID-19 rendered many travelers hesitant to fly, Boeing turned to this leader and 32-year veteran who's worked on everything from cabin systems to seats, lights to stowage bins.

He leads the technical team for Boeing's Confident Travel Initiative, a cross-functional effort to restore confidence in air travel. Freeman says technology will play a major role to make an airplane interior even safer than it already is.



IQ: What are the most promising technologies you're evaluating to sanitize the inside of an airplane?

DF: Ultraviolet light shows the most near-term potential. It sanitizes quickly and minimizes the use of liquid disinfectants on electronic components.

We are studying two wavelengths of UV light. 254-nanometer UV is the most common and is used on many current applications. We are also pursuing 222-nanometer UV, which is not as common and takes a special bulb. Boeing has a number of patents around this technology, and we are joining with universities to further validate safety and effectiveness.

Data collected so far suggests 222-nanometer UV is even more effective at killing viruses than 254 nanometer. We are striving to bring this 222-nanometer technology to our customers as a hand-held wand, along with solutions embedded in the cabin. Boeing is working with third parties to bring the UV wand to market.

We are also evaluating anti-microbial coatings, which are intended to remain on a surface, providing a hostile environment for viruses and bacteria, killing them over time. Thermal technology is in our sights too, using heat to disinfect, as well as air ionization, which puts a charge in the air that theoretically inactivates viruses.

PHOTO: MARIAN LOCKHART

IQ: Which one is furthest along?

DF: We have been analyzing UV lights for a number of years. Our team developed UV light prototypes for lavatories, and we continue to advance the concept. We have been able to leverage this work to accelerate the development of a hand-held wand. We are working to rapidly commercialize this invention to help our airline customers.

IQ: What has been the most challenging technical issue?

DF: Providing the right solutions to our airline customers that support their business and are still safe for the airplane.

The best engineering designs/solutions are those that find the perfect balance between all the constraints and requirements. This is a foundational element of systems engineering.

But enter the pandemic. Passenger demand diminishes. Airlines need to react and are rapidly developing changes to operations to address both the physical threat of the virus and perceived threats that undermine passenger confidence. This is the environment in which we found ourselves: unclear requirements for disinfection, no established supply chain for chemicals, evolving regulations around the world.

“We understand the requirements, react with urgency, stay the course with technical integrity and support our customers.” –Dan Freeman

What do good engineers do? They start with the requirements. We went to the United States Environmental Protection Agency list to determine which disinfectants are effective against SARS-CoV-2 and, of those, which are compatible with our interiors.

In parallel, we began lab testing, pulling in our design teams to ensure we had the right tests in place. The pressure was intense. Our teams worked hand in hand with our customers to understand what they needed and promptly feed their replies to the technical teams. We adjusted the plan as new data came in.

The job is not over, and the team will continue to refine its approach. We understand the requirements, react with urgency, stay the course with technical integrity and support our customers.

IQ: How do potential advancements restore confidence in air travel?

DF: For people to want to travel, they need to feel safe.

Safety has both a physical and psychological element. Using chemical disinfectants, per our recommendations, absolutely enhances the safety of an airplane. And implementing additional technologies improves operational efficiency and mitigates some of the risks chemicals may introduce.

Our mantra is “data-driven solutions,” which we strive to achieve every day.

“Passengers need to know what is being done, and that it works.” –Dan Freeman

Physical safety is not enough, though. Passengers need to know what is being done, and that it works. For example, technologies such as UV could have visual indicators in the cabin. (Think of a light outside a lavatory that blinks when it has been UV-disinfected between uses.) We are collaborating with airlines to communicate our collective efforts.

IQ: What qualities define a successful, new technology?

DF: A new technology must show improvement in some key feature without backtracking. As we look at UV, coatings, ionization, thermal disinfection or other technologies, they must be foundationally effective at killing the virus and safe for operators to use with airplane equipment and materials. There is no compromise on this.

After that, they must make the airlines more efficient. With fewer flights, our customers have been able to implement robust disinfecting procedures. As passenger travel restarts, we need to support the airline return to faster turn times and more frequent flights without compromising improved disinfection standards.

SEE THE LIGHT
UV wand operators can pass UV light over high-touch surfaces, sanitizing everywhere the light reaches.

IQ: In a general sense, how has the pandemic sparked innovation?

DF: Any global crisis helps crystalize a sense of purpose. This intense focus for our technical team helps prioritize activities and accelerates progress. It also drives a heightened level of collaboration.

The pandemic significantly accelerated existing work. To be honest, prior to the pandemic, there was a lot of internal debate on whether we should invest in certain technologies and if there would be any benefit to our customers. That all changed overnight.

“People want our support, advice and leadership, and we are engaging on all fronts.” –Dan Freeman

The pandemic also lowered the barrier to collaborate externally. With the aviation industry at stake, we have swiftly connected with universities, partnered with government agencies and led engagements with major industry organizations. People want our support, advice and leadership, and we are engaging on all fronts.

IQ: Can you speak to the power of a cross-functional team?

DF: The technical team of engineers and scientists have joined forces with every function in the enterprise to develop a comprehensive plan that involves analytics and analysis, communications, our international team, each division in the company and our partners in the corporate office. We are reaching out beyond the airplane to address the travel journey as a whole.

It is only together that we can have the impact needed to restore confidence to passengers and crew worldwide. It is exciting and humbling to be a part of this initiative. **IQ**

Confident Travel Initiative

The mission of Boeing’s Confident Travel Initiative is to be a leader in the global effort to provide passengers and crew a safe, healthy and efficient travel experience. Working across the industry — with airline customers, global regulators, industry stakeholders, infectious disease experts, academia and behavioral specialists — this is an unprecedented international effort.

Three objectives provide multiple layers of protection:

- Prevent the virus from reaching the airplane.
- Protect the airplane and keep it free of viruses through disinfecting and cleaning.
- Limit potential transmission of viruses on the airplane.

TIGHT SPOT LIGHT

The UV wand is ideal for intricate, compact spaces like a flight deck.

PHOTO: PAUL WEATHERMAN

Top Shelf Engineer

Ashley Basnight doesn't push the easy button.

BY LAURA FENTON AND ED MUIR,
BOEING WRITERS

HOMEMADE

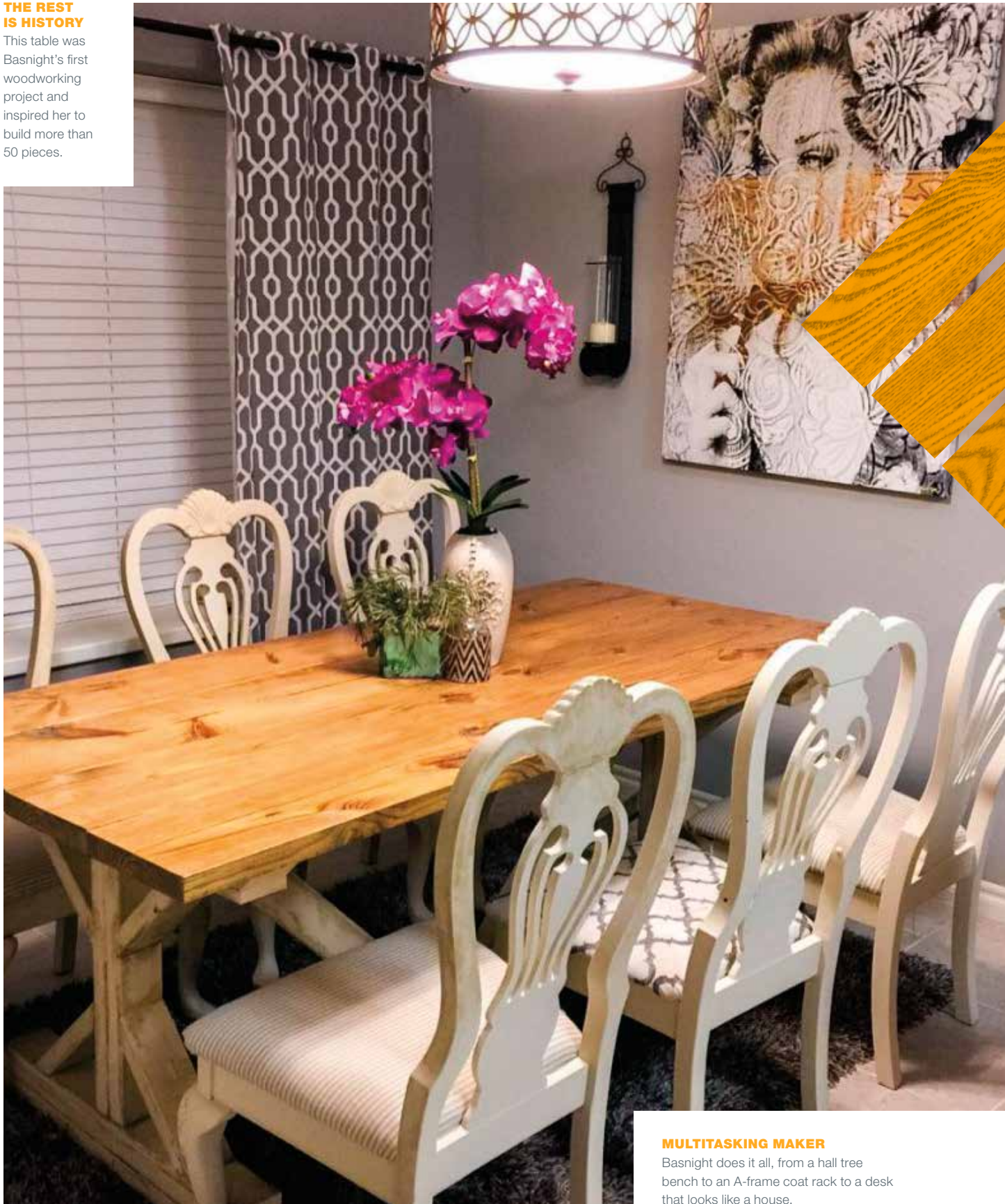
Ashley Basnight, a Boeing software test lead, uses her engineering acumen in her garage/workshop in Norman, Oklahoma.

PHOTO: RANDY ANDERSON

When she wanted the perfect kitchen table for her new house, she didn't go out and buy one. She made one. With no woodworking experience, she essentially taught herself. She was surprised how well it turned out. "So I thought maybe I could build as a hobby," she said.

THE REST IS HISTORY

This table was Basnight's first woodworking project and inspired her to build more than 50 pieces.



MULTITASKING MAKER

Basnight does it all, from a hall tree bench to an A-frame coat rack to a desk that looks like a house.

PHOTOS: ASHLEY BASNIGHT



Her new hobby didn't mean making merely a birdhouse or a cutting board.

For Basnight, it meant more than 50 projects in her garage shop, including a one-of-a-kind sliding barn door media center, cabinetry in her kitchen and a 20-foot backyard deck.

As a software engineer for the Boeing B-52 program in Oklahoma City, Basnight found that her analytical mind fit right into the world of woodworking. She got so good so fast, she started a blog featuring her work along with tutorials to help other DIY diehards.

That connection with other woodworkers brought Basnight to the second season of NBC's "Making It," hosted by Amy Poehler and Nick Offerman.

The show features builders competing for the title of Master Maker and a \$100,000 prize. Though she didn't win the cash, Basnight said the chance to create something from scratch, on deadline, was exhilarating.

The competitions often begin with Poehler and Offerman's countdown, "Three, two, one, let's make it!" And off the contestants go. "I got a total adrenaline rush. It forced me to think quickly on my feet during an intense situation," she said, adding that she also experiences that deadline pressure as a software test lead and product owner for testing.

PHOTO: EVANS VESTAL WARD/NBC



TV STAR

Ashley Basnight with hosts Amy Poehler and Nick Offerman on the set of NBC's "Making It" in Los Angeles.



SELFIE WITH A STAR

Ashley Basnight with comedian/host Amy Poehler in Los Angeles.

PHOTO: ASHLEY BASNIGHT

“I got a total adrenaline rush. It forced me to think quickly on my feet during an intense situation.”

ASHLEY BASNIGHT

The complexity of computer science appealed to her innate inclination to push herself while growing up in Moyock, an unincorporated commuter town in North Carolina, just south of the Virginia border. She also watched as her aunt, Joycelyn Collins, showed what hard work and ambition look like. Basnight said Collins was a crucial early role model, working more than 20 years for Microsoft. She introduced her niece to the world of engineering.

“We have a lot of mathematically inclined members of our family, and Ashley was always curious about the work I was doing,” Collins said. “So while I might have helped inspire her to enter the engineering world, Ashley did the work herself and was always extremely motivated to keep pushing forward.”

Basnight attributes part of that motivation to her aunt. “She is super successful, and watching her made me more interested,” Basnight said.

At the time, Collins was also one of the few Black women whom Basnight saw in a technology career. “That made it even more intriguing to learn and get into a field where I don't see many people who look like me.”

Like her aunt did for her niece, Basnight is honored to lead a path for other Black women to consider engineering as a career.



Basnight: 'Now is the time for change'

A Boeing engineer's thoughts on Black Lives Matter

As a young African American woman in the engineering field, I always found it somewhat difficult finding my footing in the workforce, navigating a place where I didn't see many individuals who looked like me. As the years progressed, I learned how to find my purpose and voice at Boeing, but I also experienced trials and adversity within that process. I believe these experiences further heightened my desire to be an advocate for African American individuals and led me to be passionate about the Black Lives Matter (BLM) movement and equality in the workforce.

BLM recently found a place in corporate America after the death of George Floyd, an unarmed Black man in Minnesota. Most have seen the video of a police officer kneeling on the neck of Floyd, for more than eight minutes, while he pleaded, "I can't breathe." This prompted a wave of statements from organizations expressing solidarity and a commitment to addressing systemic racism. Although events like this have happened before, this one seems different compared to others related to police brutality. Though true equality has yet to be achieved, now is the perfect time for change. I'm hopeful that change will happen.

-Ashley Basnight

“That made it even more intriguing to learn and get into a field where I don't see many people who look like me.”

ASHLEY BASNIGHT

"I feel like I can be an inspiration," she said. "When there are things people don't normally do, sometimes they may be scared, or they may be wondering, 'Can I do this?'"

That, more than anything, is why Basnight runs toward a challenge. "Going into this field provides an example for others to show it is possible. It's a demanding career, but it's worth it when people come up to me and say, 'Seeing you in engineering makes me more interested in it.'"

Her Boeing career began in college. While earning a Bachelor of Science in computer science from Elizabeth City State University in North Carolina, she landed an internship in 2012 at a Boeing facility in Wichita, Kansas. Less than a decade later, she is a member of the software sustainment team for the B-52 program in Oklahoma City.

At times in her career, Basnight has been the only Black engineer on her team. She sometimes felt she had to outperform to repeatedly prove herself.

"I wanted to make a good impression so people would be open to more women-of-color engineers, setting the stage for others," she said, noting that her hobby offers a similar opportunity for change. "Engineering and woodworking are kind of the same in that woodworking is male dominated. More women are getting into it, but people are still surprised when I say I build things. I want to show women we can do it. We're just as strong. We have the same abilities as men. We can still build things."

Although Basnight was eliminated in the third episode of "Making It," she is thankful to have participated. She feels her engineering skills helped her on the show.

"When you're in a timed challenge on TV, you have to think fast on your feet," she said. "There were a couple of times where, the design I had in my head, where I realized it wouldn't work out. I'd have to do calculations on the fly and use my math skills. The engineering side of me kicked in."

PHOTO: ASHLEY BASNIGHT

WOOD WORLD
Basnight often writes her blog surrounded by her work. She made the sliding barn door media center behind her.



She uses those skills every day on the job and has spent her entire Boeing career working with the B-52 program. She credits her longevity to being part of an Agile engineering team, one that divides big challenges into measurable chunks of work. "You're constantly reassessing as you go," she said. "It creates an opportunity to identify challenges more quickly."

Working with her team of about 90 people allows for more and tighter collaboration. They meet in scrum teams every day to answer three questions: What did you do yesterday? What do you plan to do today? What are any impediments you're experiencing? These consistent check-ins foster efficiency. The teams are also closely aligned as they sprint toward deadlines. "And we can talk to the customer on a consistent basis. It allows us to deliver more of what they want," Basnight said.

She feels blessed to get to live her two passions: engineering and woodworking. She looks forward to going to the lab and seeing her handiwork come to life. "It's so cool to be able to say, 'Hey, I coded this page' that will end up on a huge, military airplane," she said, adding that she gets the same charge out of the start-to-finish of a new project in her garage. "It's hands-on and taps into my creative side. I can customize. And the engineer in me comes into play with the measurements and calculations and determining how a piece works in a space."

She also recently sold that table that launched her woodworking career, making room in her kitchen and in her life for whatever new adventure is on the horizon.

That horizon is sure to include countless lines of code, splinters and Basnight's relentless dedication to perfection. She is motivated by the countdown in her head, "three, two, one, let's make it!" In many ways, she already has. **IQ**



Virtually Overnight

How Boeing protected its information, network and global workforce working from home

In March 2020, virtually overnight, more than 90,000 Boeing employees — approximately three-fifths of our workforce — started working remotely. Many of our stakeholders, suppliers and customers experienced the same sudden transition to working from home full time.

I lead Boeing's Information Security Governance and Supply Chain team, which defines enterprise requirements for information protection and cybersecurity for both our employees and suppliers. Our Boeing InfoSec team protects the network, assets and information of a global workforce on a daily basis and supports and protects our customers, suppliers and partners around the globe.

As I think back over the past months, themes and trends emerge that underscore the importance of solid cybersecurity and information protection principles. Our work hasn't changed during the COVID-19 crisis, but it has been magnified, accentuated and complicated in ways we had not anticipated when the year kicked off.

Telecommuting and personal devices

When more than 90,000 employees are suddenly thrust into a remote work environment, the cybersecurity and information protection threat landscape changes drastically. The first challenge we faced was how to support employees taking Boeing devices home to facilitate their new remote work situations. Many employees who had not previously worked from home did not have adequate infrastructure in place to support this change.

No longer do we have gates, guards and physical access controls in place to provide an initial layer of protection for our information and devices. Instead, we have housemates and myriad unknown factors that employees have to deal with to comply with our policy requirements in their unique environments.

That pushed InfoSec, along with our End User Computing team, to focus on tracking, supporting and protecting our computing assets as they headed off to employee homes.

GRAPHIC: BOEING

Boeing Network by the Numbers			
	Pre-Pandemic Average	Peak After COVID-19	Current Average
Concurrent Remote Connections	35K	90K	80K
Network Bandwidth Usage	15%	40%	30-40%

Collaboration

Collaboration is crucial to much of the work we do, and remote environments make collaboration significantly more difficult. Most employees were familiar with virtual meetings prior to COVID-19, but the sudden shift to every interaction being over the phone or via virtual meetings forced us to change how we work.

Questions immediately arose about what tools employees could use to support Boeing business activities. This was complicated because there were many different options for supporting the transition and no one option clearly stood out as the best. Boeing employees needed to know which collaboration tools they could use for which purpose and which ones were prohibited due to known cyber vulnerabilities. Providing clear guidance was critical to supporting our global business.

As employees sought alternatives to face-to-face interactions, we also had to address the proliferation of mobile apps that are used on a daily basis in our personal lives. A useful app may not be a secure method of conducting business. InfoSec rapidly responded to questions about the differences between mobile apps versus web platforms and why the risk was different. We also worked with individual teams to help meet their needs in a secure way so we could continue to facilitate business in the virtual environment.

Information protection and supporting safe cyber behavior

Boeing employees work with extremely sensitive and highly regulated data on a daily basis. This makes them prime targets for adversaries who would use their access to gain an advantage in the global market. We continually communicate to our employees how critical it is that they be aware of phishing attempts and social engineering, and this has become even more critical now that we are all taking our work home with us.

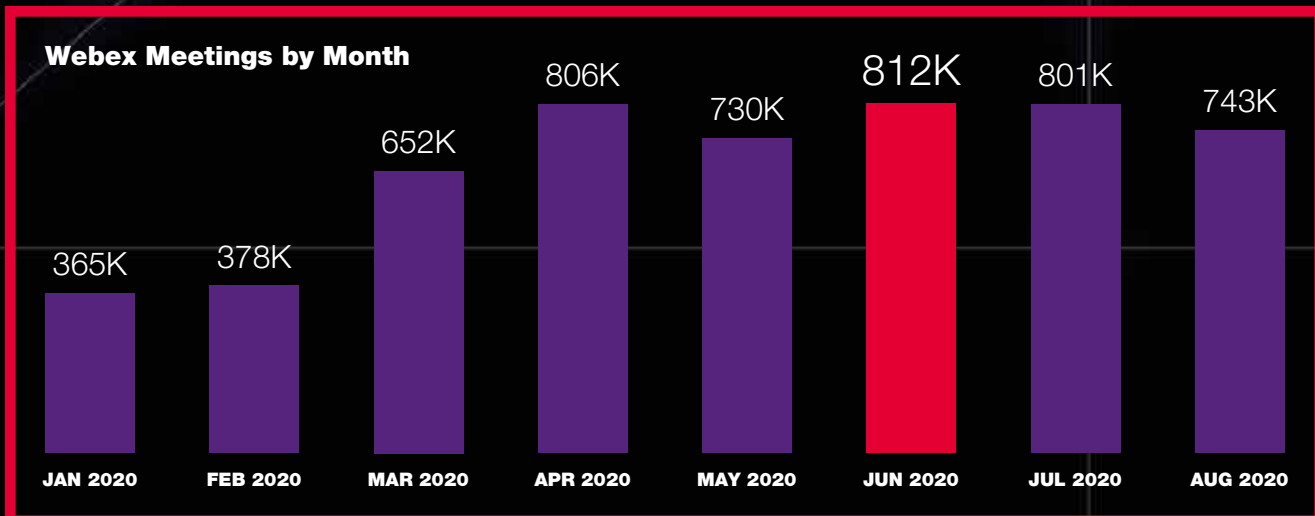
In addition to the cyber risk, employees now need to be keenly aware of the sensitivity of the information they are working with, as they don't have the standard protections Boeing facilities provide.

Boeing has also improved the clarity and "consumability" of our information protection training and guidance. We developed targeted information protection training and updated our Information Protection Standards Manual to address many of the complexities employees were (and are) dealing with while working from home.

However, simply publishing updated guidance is not enough to truly move the needle in such unprecedented times, so we took additional, proactive measures to ensure employees both understood the cyber threat and could protect information without having to think about it. To help employees spot and react to phishing attempts and other cyber threats, we added a banner to external email to remind employees to think twice before clicking on links. We also implemented technical controls, such as blocking write access to USBs by default, to help employees stay within the bounds of policy and protect our information and devices from inadvertent loss or compromise.

Suppliers

Our suppliers also face cybersecurity threats, providing an additional dimension of risk that we must account for. Boeing's supply chain consists of more than 12,000 suppliers that have differing levels of cybersecurity maturity. During the COVID-19 pandemic, we needed to ensure their continuity of operations and continued performance — so they could continue to support Boeing and the aerospace industry, including our U.S. defense and allied customers.



GRAPHIC: BOEING

ILLUSTRATION: GETTY

National Cybersecurity Awareness Month, held annually in October, is co-led by the National Cyber Security Alliance and the U.S. Department of Homeland Security.

A few of their quick tips to help people be safer and more secure at home and at work:

- **Keep a clean machine:** Having the latest security software, web browser, apps and operating system is the best defense against viruses, malware and other online threats.
- **Lock down your login:** Enable the strongest authentication tools available.
- **When in doubt, throw it out:** Whether at work or in their personal lives, employees should know not to open suspicious links in email, tweets, posts, online ads, messages or attachments — even if they know the source.

Some suppliers needed virtual work clauses added to their contracts and assessments of their proposed access methods to enable them to handle Boeing information or access Boeing assets during the COVID-19 stay-at-home orders issued by states. Some suppliers have had to deal directly with the rise in cyberattacks COVID-19 has produced. Our Information Security team has supported our suppliers through each of these activities over the past several months, revising contracts, assessing proposed connection architecture options and determining if ransomware attacks on suppliers have had any direct impact to the Boeing network.

More granularly, prior to COVID-19, some suppliers had operated from Boeing facilities or supplier facilities with trusted connections. Now these suppliers around the globe had to use their home Wi-Fi and hop through a variety of VPN connections to conduct their work. Again, we partnered with them to ensure appropriate access and alignment of cybersecurity expectations and execution.

Closing

Work doesn't stop in a crisis. Even prior to COVID-19, our work landscape was increasingly digital and faced burgeoning cybersecurity threats. COVID-19 has proven the resiliency of our information security controls to protect and enable our workforce, information and infrastructure in support of efficient, stable operations in a dynamic environment.

We have been able to continue our day-to-day operations with clear and thorough guidance for our teams, partners and suppliers; explore new capabilities while reinforcing our foundational principles; and operate securely in a world of uncertainty. **IQ**

About the author:

Amanda Silver is a Boeing Information Security senior manager.

PHOTO: BOEING



YOUR FUTURE IS BUILT HERE

Jackie Wong
Acoustics Engineer

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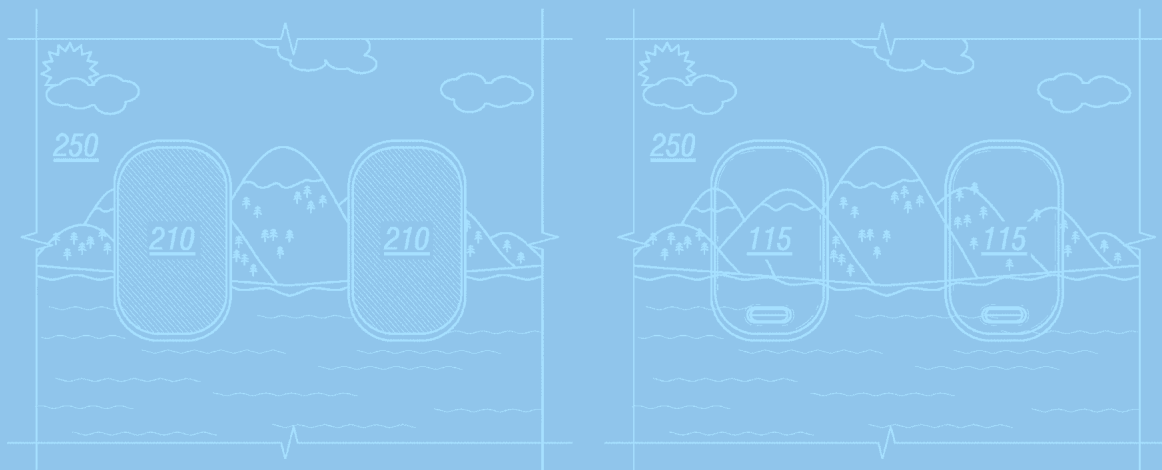


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PatentPower

Boeing's latest ideas and technical breakthroughs recently granted or published by the U.S. Patent and Trademark Office.



Mood Lighting

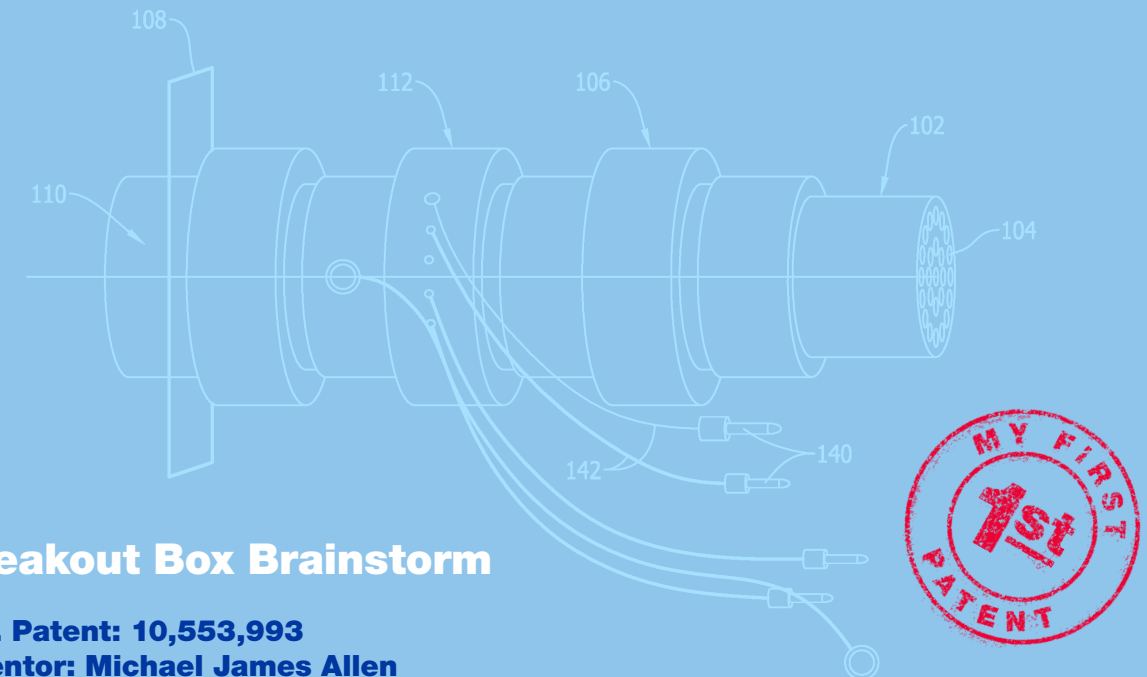
U.S. Patent: 10,696,404

Inventors: Jagdish T. Madhav, Barry C. Colwell

Curiosity can turn on lightbulbs. In 2012 Jagdish Madhav was curious about how augmented reality (AR) may help auto drivers see around blind spots. While reading an article in a technical journal, the proverbial idea bulb appeared overhead. He wondered, if it works for automobiles, why not around airplane windows?

What started as a thought evolved into a series of inventions, one of which was recently protected as U.S. Patent No. 10,696,404, "Application of artificial intelligence to implement augmented reality, virtual reality, and mixed reality to enhance passenger experience to flying with mood lighting."

This new patent describes a method for providing sidewall illumination by replacing expensive sidewall lights with tiny pico projectors, which have a long shelf life and cost considerably less than conventional lights. Also, by adding cameras facing outward under windows, supplemented by AR, projectors can transform mood lighting into live action. Where there was once limited color and brightness, now a variety of shapes, colors and scenes can reflect both actual and virtual reality. Thanks to this innovation, passengers may enjoy a snow-capped mountain, a sailboat on the ocean or soothing rain. Visuals can change at the push of a button by a flight attendant.



Breakout Box Brainstrom

U.S. Patent: 10,553,993

Inventor: Michael James Allen

The first attempts at invention are often destruction. As a 10-year-old, Michael Allen wanted to transform his 10-speed bike from red to yellow.

"I disassembled everything so I could paint the frame," Allen said. "When I tried to put it back together, the pedal mechanism would not turn anymore. I took it apart several times but never could get it to work again."

Fast forward almost four decades. Now an avionics engineer for Boeing, Allen encountered challenges evaluating aircraft modification performance, specifically installations requiring a breakout box, the tool used to access the signals requiring validation. It was an arduous and time-consuming task because it required installation and removal of temporary wiring to collect operational aircraft performance data. The breakout box was often made of metallic materials, and individual signal shielding was not typically provided to the wires inside, which can impact signal integrity.

But Allen had an idea: What if he could make the connector on the aircraft be the test interface, phasing out the need for a breakout box?

The purpose of the connector is to maintain the integrity of the aircraft installation as much as possible while still enabling test and measurement activities. Independent signal generator or signal analysis equipment is still required, such as a laptop with the correct software or a test set. The connector eliminates the need for a lot of extra wiring and removal of avionics equipment in order to use a breakout box. The continuity of the mechanical and wiring installations is better preserved using this breakout connector.

His brainstorm resulted in his first patent, "Avionics system interface electrical connector," U.S. Patent No. 10,553,993, issued Feb. 4, 2020.

The patent describes a quick-disconnect cable harness signal breakout adapter for aircraft connectors. This device provides easy access to all aircraft signals passing through the connector with a minimum of signal line interruption and electromagnetic interference, thus providing clean signal outputs to data analysis computer programs and/or aircraft set interfaces.

Back to the bike, which he never did ride again. "It probably ended up in the trash when we moved," he said. But without that broken bike, he may never have found invention, his life's work.

Technically speaking,



the



Stewards of Excellence

The newest Boeing Senior Technical Fellows and Principal Senior Technical Fellows represent expertise in a variety of fields, such as artificial intelligence and machine learning, additive manufacturing, software, simulation and training, product security and rotorcraft design.

Recognized as technology leaders inside and outside the company, they assumed new roles this August in the executive tier of the Boeing Technical Fellowship, which represents less than one-tenth of 1% of the technical workforce. They are trusted consultants, advisers and mentors and will play an even more important role in the future as stewards of the company's design practices.

Beth Biddle

Senior Technical Fellow

Advanced Learning

The most rewarding parts of my career have been the opportunities to observe our product and service users in their operational environments. From a weekend shadowing an Army instructor team during a large training exercise — the tactical operations command activities, the urban combat scenarios, the Humvee rides in blackout conditions — to observing commercial pilot training at our global flight training campuses, every experience has given me a deeper understanding of our users' diverse challenges and perspectives as well as their similarities.

PHOTO: KEVIN MALCOLM



Mike Bryan

Senior Technical Fellow

Engineering Test Pilot

One of the most memorable episodes in my career came in July 2010 when I was honored to be the captain of the first international flight of a 787. We flew from Seattle to the Farnborough Airshow to present the Dreamliner to the world. After a 4,200 mile night flight, we arrived overhead exactly "on time" and, for the next week, proudly showed off this amazing aircraft. As test pilots, we are at times in front of the camera, but none of our accomplishments would be possible without the superb technical skills and dedication of the entire team.

PHOTO: MARIAN LOCKHART



Mark Boyd

Senior Technical Fellow

Software Architecture and Engineering

There are two aspects of my work I find most rewarding: delivering products that customers use (Department of Defense and airlines) and working with great people to produce them. As I look back over my career, the relationships I have created continue to bring happiness to me long after the projects are over. And when I hear about one of the products we've delivered being leveraged by our customers and bringing value, that really puts a smile on my face.

PHOTO: JAY SNIDER



Pat Estell

Senior Technical Fellow

Structures Engineering

The highlights in my career have been the multiple opportunities that I have had to work with amazing dedicated teams to integrate innovations in our new airplanes, whether it's been new structural configurations, lighter-weight materials or advanced manufacturing methods. My absolute favorite thing is to watch the airplane you helped design take off for the first time!

PHOTO: MARIAN LOCKHART



Miriam Grace

Senior Technical Fellow

Systems Architecture

Being selected as a Senior Technical Fellow means finding the highest-value opportunities for transforming our digital customer experience and customer information architecture, our global technical learning architecture, and the diversity of our Boeing Technical Fellowship.

PHOTO: MARIAN LOCKHART



Bobby Mathew

Senior Technical Fellow

Vertical Lift Design

I am humbled and incredibly honored to become part of this illustrious group of Senior Technical Fellows. This position provides me with greater opportunity to collaborate and address key technical challenges across The Boeing Company. I am especially excited about opportunities to influence future technology developments in my area of expertise.

PHOTO: ERIKA RODRIGUEZ

Dragos Margineantu

Senior Technical Fellow

Artificial Intelligence and Machine Learning

I am most excited about building computing systems that assist humans (experts and non-experts) in high-stakes applications in real time, such as pilots in the air, people in the factory and support teams performing services for customers in the field. Boeing and the entire research field have made great advances in autonomous decision systems over the last two decades, but the next big challenge is to develop highly trusted and truly robust human-machine teams that together can accomplish a goal.

PHOTO: MARIAN LOCKHART



Steve Monson

Senior Technical Fellow

Simulation and Training

I'll never forget the call I received while at Disney World, where I took my family for vacation. I had spent most of the year away from home leading a Boeing proposal team with partner QinetiQ on a project for the United Kingdom Ministry of Defence. "We won!" The project brought together so much of my technical experience: virtual military pilot training devices, virtual threat systems, simulation interoperability protocols, local/wide area networks, etc. We built the Royal Air Force Air Battlespace Training Centre, which provided pre-deployment training for the British Army and established Boeing Defence UK's distributed training capability.

PHOTO: ERIC SHINDELBOWER



Carol Nguyen

Senior Technical Fellow

Contamination Control

One of my favorite aspects of my work is the opportunity I get to help resolve critical technical issues for spacecraft, aircraft and ground hardware across the company. I have been able to work on so many amazing projects and proposals — it gives me goose bumps just to think about them. One of the most memorable moments in my career came when I was able to resolve a potentially hazardous chemical issue just prior to a space shuttle launch. It cleared the launch constraint, and the launch was a success.

PHOTO: JAY SNIDER



Amy Reiss

Senior Technical Fellow

Product Security

I have lots of fond memories of the Sea Launch program because it was such a crazy idea to launch satellites from a converted oil rig in the middle of the Pacific Ocean, in a joint venture with companies from Russia, Ukraine and Norway and for customers from all over the world. Nevertheless, we did it successfully 32 times. And I had the honor to serve as technical mission manager and lead multidisciplinary analytical integration for three of those voyages.

PHOTO: MARIAN LOCKHART



John Palmer

Senior Technical Fellow

Systems Engineering Architecture and Integration

Boeing is a great company in part because there are so many opportunities contained within it. One of those for me was Connexion by Boeing, where a group of us were the first to put internet in the sky. I saw the entire development life cycle in one program — concept to design, production, fielding, support and decommissioning — driving home the life-cycle significance of the systems engineering discipline.

PHOTO: MARIAN LOCKHART



Robert Smith

Senior Technical Fellow

Avionics and Sensing

Becoming a Senior Technical Fellow is a great honor and will allow me to contribute to even more highly technical projects and exchange ideas with more talented colleagues and senior leaders across the breadth of Boeing. It is humbling that the enterprise has recognized my contributions in this way. The Technical Fellowship is a terrific organization that has helped me to develop the leadership, creativity, collaboration, innovation and empowerment skills that I use to advance our culture of safety, quality and technical integrity.

PHOTO: MARK CAUDILL



Richard Aston

Principal Senior Technical Fellow

Space Systems Structures and Additive Manufacturing

One of the most memorable times of my career so far was working the development of the 702SP stacked all-electric spacecraft, from the initial concept of stacked vehicles all the way through its first launch. I had the opportunity to attend the launch at Cape Canaveral Air Force Station along with my son, who was 15 years old. It was a once-in-a-lifetime thing to share that whole experience with him: visiting the pad the night before the launch when the rocket was illuminated with spotlights; attending events with customers; and, of course, the launch itself.

PHOTO: JAY SNIDER

Principal Senior Technical Fellows



Jeff Miller

Principal Senior Technical Fellow

Production Engineering

It is a tremendous and humbling honor to be selected as a Principal Senior Technical Fellow, just as it is humbling to watch the first flight of a new rocket, the first takeoff of a new aircraft, and even the first successful use of a new production system or facility that you worked on. These brief moments represent the culmination of years of hard work and commitment of many people who overcame countless hurdles to transform ideas into world-changing products. There's nothing more rewarding.

PHOTO: MARIAN LOCKHART



Alex Rubin

Principal Senior Technical Fellow

Composite Materials and Fabrication Technologies

The future of the technologies and applications for structural composites is bright. We are optimizing performance, reducing cost and achieving high quality at high production rates. To make this happen, our Boeing teams are making improvements in many areas: polymer science, innovative and efficient manufacturing processes, optimized automated production systems, and model-based engineering systems. All of this creates a digital thread throughout the life cycle, from conceptual design to in-service support to recycling.

PHOTO: ERIC SHINDELBOWER

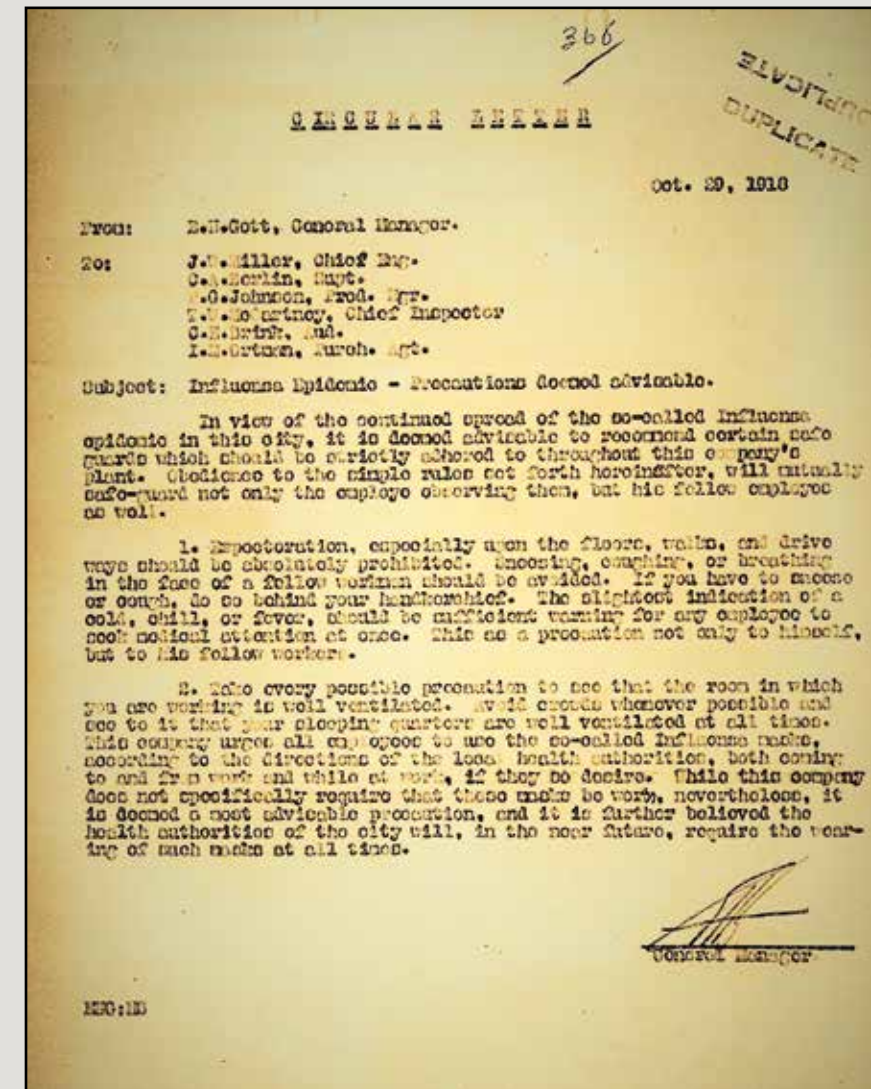
1918 FLU PANDEMIC: WHAT'S NEW IS OLD

**“AVOID
CROWDS
WHENEVER
POSSIBLE.”**

**“THIS COMPANY
URGES ALL
EMPLOYEES
TO USE MASKS.”**

**“THE SLIGHTEST INDICATION OF A
COLD, CHILL, OR FEVER,
SHOULD BE SUFFICIENT
WARNING FOR ANY EMPLOYEE
TO SEEK MEDICAL
ATTENTION AT ONCE.”**

Internal memo reveals Boeing's history of pandemic response.



Messages from 2020? Try 1918. In an all-employee memo from the 29th of October of that year, when “expectoration” was clearly an issue, those directives (left) are preceded by the first:

“Expectoration, especially upon the floor, walks, and drive ways should be absolutely prohibited.”

The 1918 flu pandemic had made its way to Seattle. It began in Europe and Asia and spread quickly among soldiers returning from the packed trenches of World War I. Ultimately, more than 500 million were infected, which amounted to roughly a quarter of the world's population at the time.

American soldiers brought the flu with them to the United States, where it was transmitted in camps and on crowded trains. Traveling cross-country via rail lines, the flu took hold in remote places such as Seattle, home of the fledgling Boeing Airplane Company.

The pandemic peaked in October 1918, prompting the company memo that also advised “sneezing, coughing, or breathing in the face of a fellow workman should be avoided.” That was in addition to the aforementioned expectoration, a reference to the popular practice of chewing tobacco.

At the Boeing plant, spittoons were provided, but according to memoirs left by Boeing seamstresses, the men weren't careful enough. The spit ended up all over floors and walls — something the seamstresses found abhorrent.

Written by company founder William Boeing's cousin, Edgar Gott, the general manager at the time, the so-called “circular letter” contained instructions with the subject “Influenza Epidemic – Precautions deemed advisable.” Today the letter lives in the Boeing Archives.

The memo reveals a number of parallels between 1918 and today, such as the importance of considering others: “This as a precaution not only to himself, but to his fellow worker.” Similar to today, Seattle-area schools, religious institutions and theaters closed to prevent the spread of the flu.

A hundred years ago, humanity dealt with overlapping pandemics, such as typhoid and diphtheria, as well as the flu. Legend has it that Benjamin Franklin was one of the first to theorize that sleeping with the windows open could prevent disease, hence the memo's guidance to “see that the room in which you are working is well ventilated.”

The flu pandemic lingered for about two years before ending in 1920. **IQ**

In a world of uncertainty, decide your future in six steps.



Foresight methods to apply in your work

Shaping the future is more practical, and practicable, than predicting it. Instead of identifying a single future state, foresight methodology provides tools to understand a set of potential futures, build resilience into our plans, monitor for signals of change and execute our plans when needed to help create our preferred future state.

1 What problem are you trying to solve?

First, you must determine what question you are really trying to answer. For example, are we trying to address how we can sell an in-development product in the future or are we trying to determine what consumers will want in the future?

Dissect your problem statement. Ensure other stakeholders are in agreement. This may seem easy and obvious, but nailing down the basic “job to be done” is often overlooked or not well coordinated.

2 Consider different time horizons.

In a highly uncertain environment, approach your assessments of the future from a range of time horizons. Different industries, circumstances and goals require flexible time

frames. For example, in response to an industry disruption, one might consider near term (present-6 months), interim (6-12 months) and long term (12 months-2 years).

For the near-term time frame, focus on rapid response and operating in a dynamic environment.

For the interim period, identify key indicators and monitor them closely for indications of future trajectory.

For the long term, articulate what an evolved future state looks like for your industry and company. Many previous assumptions may no longer hold true.

As you emerge from the disruption, explore which things will be forever changed, which will move in other directions and which will go back to resemble “the way it was before.”

3 Look at trends.

Today's trends give us a glimpse of what trajectory the future could take. Identify trends — social, technological, environmental, economic and political — that are relevant to your problem statement. Evaluate the likelihood and impact of each.

Keep in mind, trends we see today often don't change the future as much or as quickly as we might expect.

4 Revisit your assumptions.

When faced with uncertainty and ambiguity, revisit long-held assumptions. These could be referencing your chosen business model, customer preferences or technological capabilities.

An example of a changing assumption might be your product's or service's reliance on dense urbanization. How might business models be affected by a shift to more widely dispersed and less densely populated urban centers?

5 Plan for different scenarios.

Scenario planning acknowledges that decisions must be made amid ambiguity and complexity. Start by selecting the main drivers of your issue. Look at a range of possibilities for how the future might play out, including which is most likely to happen. Consider extreme cases. Reflect on which of these future states you hope comes to fruition.

To evaluate strategic alternatives, look for decisions that work in every scenario. Determine which actions have the biggest payoff but are only valid in a limited number of the scenarios. Similarly, address risks, how likely they are to come to fruition in each scenario and how their impact changes in each. Define actions that can be taken to close the gap between your most probable future state and your preferred future state.

In the simplest form, a 2-by-2 matrix can be used to explore opposite extremes of two variables and describe what the world looks like in each resulting quadrant.

6 See the big picture.

When you consider your trends, assumptions and scenarios, be sure to take a holistic view. We often default to linear pathways when considering technology developments and business assumptions. But nothing happens in isolation. Multiple trends or events could play off of each other to magnify or minimize the impact they might have.

As a separate exercise, go back to your trends and assumptions to review how several elements might combine to aid your momentum or block your way. Include items from different categories such as a technology development, an economic change and a societal shift.

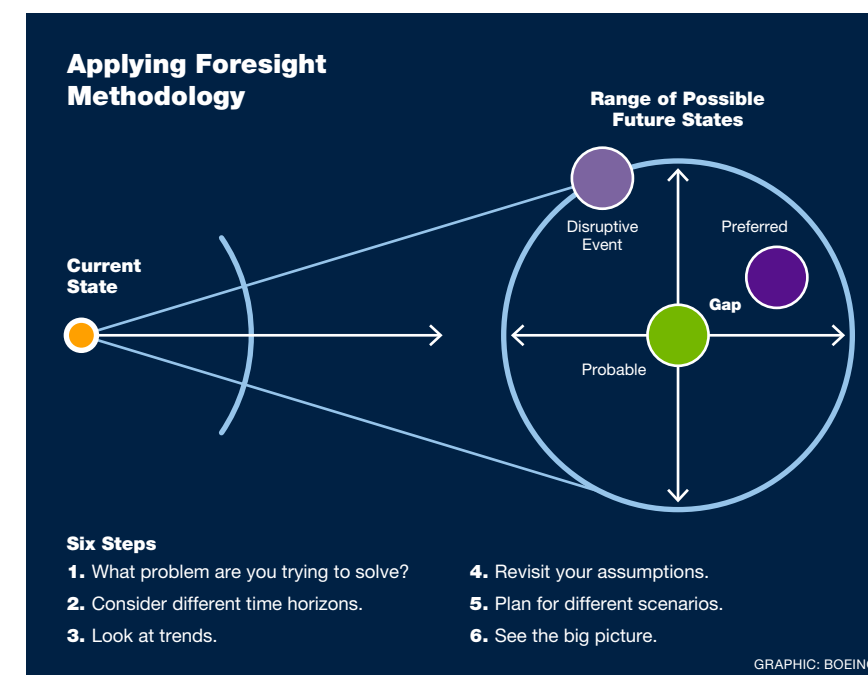
Once you have explored using these tools, develop a plan of action. Gather stakeholders and discuss options. Identify sign posts. It is more efficient to have difficult conversations while you have time to plan and research, rather than wait until urgent, reactionary measures are necessary.

In the midst of an unpredictable situation, decisions feel risky and paralyzing. No one can know what happens next. But you can turn the uncertainty into strategic advantage by shaping the future into your preferred future. And foresight methodology can help. IQ

ABOUT THE AUTHOR:

Marna Kagele is a Boeing Technical Fellow in systems engineering and strategic foresight.

PHOTO: MARIAN LOCKHART



A drone's-eye view of a C-17 Globemaster III between missions in Hungary

"A couple of us from the Boeing Hungary team came up with the idea to take a night shot of the bird with all the lights turned on. To make sure the jet was properly illuminated, we placed additional light carts underneath the wings and the aft of the fuselage."

– Photographer Tamas Fekete



A high-lift wing, four-engine, T-tailed **military transport aircraft**.



To **combat COVID-19**, operators have deployed C-17s to deliver personal protective equipment, carry critical medical supplies, repatriate citizens and transport patients.



275 in operation worldwide, including **222 operated by the U.S. Air Force** out of 16 locations.



The United Kingdom, Australia, Canada, Kuwait, Qatar, the United Arab Emirates, India and the **12-nation Strategic Airlift Capability** operate the C-17 Globemaster III as well.



Cruise speed is approximately **450 knots (0.67 Mach)**.



Can take off and land on runways as short as 3,500 feet (1,067 meters) and only 90 feet (27.4 meters) wide and can still turn around using a **three-point star turn** and its backing capability.



Expected to reach **4 million flight hours in 2021**, making it one of the fastest strategic airlifters to achieve this feat.



PHOTOGRAPHER

Tamas Fekete and the Boeing Hungary C-17 maintenance team

PLACE

Pápa Air Base, Pápa, Hungary (Apron M, Spot M3)

DATE

Dec. 11, 2019

TIME

1640 Central European Time

DISTANCE

361 feet (110 meters) AGL (above ground level)

CAPTURED BY

Drone quadcopter

F-15EX

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