National Aeronautics and
Space Administration

Together, We Discover

2020 ANNUAL REPORT

NASA'S LANGLEY RESEARCH CENTER

Langley Research Center's leadership team is composed of Center Director Clayton Turner, above left; Deputy Director Dave Young, top right; Associate Director Lisa Ziehmann, middle right; and Associate Director for Technical Kevin Rivers, bottom right.

Langley personnel stayed cohesive and productive throughout a difficult year.

Unity Brings Progress

Success walked alongside struggle in 2020 — an unprecedented, unforgettable year.

At NASA's Langley Research Center, highlights included a visit from Vice President Mike Pence, construction of our Measurement Systems Laboratory, and vital contributions to space exploration, Earth science campaigns and innovation in aeronautics.

Of course, other memorable moments were difficult ones. The COVID-19 pandemic touched us all, some tragically. I believe we honor the memories of loved ones by working together toward groundbreaking achievements for our agency, our nation and all humankind.

Laboring on high-profile projects and behind-the-scenes support, Langley's workforce showed amazing focus and resilience in 2020. We learned new ways to work. We succeeded even in tough circumstances.

In our commitment to unity and excellence, we follow in the footsteps of Langley heroes like Katherine G. Johnson, who passed in 2020, and the late Mary W. Jackson, who was honored when NASA named its Washington, D.C., Headquarters building after the agency's first African American female engineer.

Their examples — and countless more — continue to guide and inspire us.

This report describes some of the exciting things Langley researchers and support professionals accomplished in 2020, a year that tested our resolve and gave us the chance to prove what's possible when we unite in pursuit of sky-high goals.

Clayton P. Turner, Center Director

NASA works to make air quality prediction as commonplace and accurate as weather forecasting.

An October 19, 2020, satellite image shows the burn scar from the August Complex fire in Northern California. The burn scar is seen in red. NASA's satellite instruments are often the first to detect wildfires in remote regions.

Fresh Insights on Air, Climate

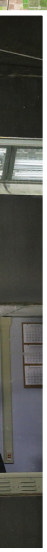
Langley scientists work to safeguard life through a better understanding of climate, weather, atmospheric composition and air quality on our home planet.

They also use knowledge of atmospheres to aid the search for life across our solar system and beyond.

On Earth, polluted air can be deadly for those grappling with respiratory diseases and underlying health conditions. When wildfires erupted across Southeast Australia in 2019 and in the western United States in 2020, Langley coordinated with NASA's **Disasters Program** to track smoke and its impact on air quality. The Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) mission traced smoke plumes as they drifted above oceans and continents. Months after the fact, the Stratospheric Aerosol and Gas Experiment, or SAGE III, instrument on the International Space Station spotted residue from fires lingering in the stratosphere.

NASA is helping to make air quality prediction as commonplace and accurate as weather forecasting. In February, Maxar Technologies and Intelsat agreed to host NASA's Tropospheric Emissions: Monitoring of Pollution, or **TEMPO**, instrument on board the Intelsat 40e mission. When launched in 2022, TEMPO will take hourly readings of air pollution across North America as part of a constellation of three instruments measuring air quality over the Northern Hemisphere.

Another of humankind's atmospheric concerns is ozone, in particular the protective layer 7 to 25 miles above Earth's surface. Essential to life on Earth, ozone there acts as a sunscreen shielding life from potentially harmful ultraviolet radiation.



Clinton Duncan releases a Dragonfly model capsule and parachute during a test at the 20-Foot Vertical Spin Tunnel.

Charles Hill, left, and John Leckey work with the Stratospheric Aerosol and Gas Experiment (SAGE) IV Pathfinder instrument during Sun-look testing at Langley in early March.

As SAGE III continues to monitor the health of the ozone layer, researchers are developing an improved version, **SAGE IV Pathfinder**. Unlike its washing-machine-sized predecessors, SAGE IV would cost less and fit in a shoebox-sized CubeSat. The new SAGE would help extend a very valuable data record. The team envisions a scenario where a small constellation of SAGE IV CubeSats would eventually orbit Earth.

Elsewhere, scientists seek to understand climate change with the help of the Clouds and the Earth's Radiant Energy System, or **CERES**, suite of satellite instruments. They measure the delicate and complex balance between how much of the Sun's energy Earth absorbs and how much thermal infrared radiation is emitted back to space. If Earth absorbs more solar radiation than it emits, an imbalance occurs and the planet warms.

To help NASA search for life throughout the solar system, Langley tests vehicle concepts that will one day help astronauts explore other worlds. Elements of **Dragonfly** — an autonomous rotorcraft designed to search for signs of life on Saturn's moon Titan — were tested at Langley in 2020. Propeller tests for the rotorcraft took place in the center's 14- by 22-Foot Subsonic Tunnel and Dragonfly's capsule and drogue parachute were tested in the center's 20-Foot Vertical Spin Tunnel. Launch is planned for 2027.

New Light for a Healthy Planet

When it comes to maintaining a healthy environment, knowledge reigns supreme.

That's why Langley's atmospheric researchers energetically stockpile and share facts about Earth's air, oceans, weather and climate.

These facts can help national leaders build a better future for everyone.

"My purpose in life is to develop and deploy instruments that can provide data needed to improve climate models," said Langley scientist Chris Hostetler. "Without accurate predictions from climate models, policymakers cannot make decisions."

Hostetler is particularly enthusiastic about prospects for High Spectral Resolution Lidar, or HSRL, a pioneering technique that's poised to expand atmospheric knowledge.

The technique gives researchers a more precise way to measure the clouds and aerosols floating through Earth's atmosphere. In the world of Earth science, aerosols refer to a variety of tiny atmospheric particles. Think dust, smoke or pollution.

Scientists are working hard to understand how the interaction of aerosols and clouds affect weather and climate. It's one of the biggest uncertainties in computer models built to predict climate scenarios.

The HSRL-2 instrument is installed into the Q-bay on the ER-2 high-altitude aircraft at NASA's Armstrong Flight Research Center in California.

HSRL can help. The technique uses lasers to measure clouds and aerosols. When HSRL lasers shoot down toward the Earth through a column of air, a small amount of light is reflected from aerosol or cloud particles back to the HSRL instrument. By carefully analyzing the properties of that light, scientists learn the altitude at which the aerosols are located and information about the particles themselves.

With enough laser shots, it's possible to build a profile of air's components in a particular place and time.

Through careful planning and execution, Langley's ACTIVATE team safely, effectively deployed despite difficult conditions created by the pandemic.

The HSRL technique provides details on size, composition, distribution and movement of particles, giving scientists an accurate, three-dimensional picture of both aerosols and clouds.

The technology's ability to produce this information means it has great potential for science.

HSRL is seen as a worthy successor to the celebrated Langley instrument CALIOP, which stands for Cloud-Aerosol Lidar with Orthogonal Polarization and is deployed on the CALIPSO satellite.

Hostetler and fellow Langley scientist John Hair began working together on High Spectral Resolution Lidar systems in 2000.

Since 2006, Langley's four HSRL units have been put to work on aircraft flying in numerous atmospheric science field campaigns around the world. "They've been hugely popular in a variety of mission scenarios," Hostetler said.

In 2020, NASA's Aerosol Cloud Meteorology Interactions Over the Western Atlantic Experiment — or ACTIVATE — used an HSRL instrument to measure how aerosols and meteorological processes affect cloud properties. Previously, the agency's North Atlantic Aerosols and Marine Ecosystems Study, or NAAMES, used HSRL to gather data on how the oceans and the atmosphere are interconnected.

HSRL's value has been proved time and time again. Now, Langley leaders have higher ambitions for the technique. Their goal is to send an HSRL to space. This kind of orbiting lidar could help create more precise climate change predictions, improved understanding of weather processes, and better air quality forecasts.

"We need to go forward in capability," Hostetler said. "The HSRL technique is more accurate than what's on orbit now and it offers more of the information that scientists need."

This is one way Hostetler and his colleagues hope to supply knowledge that leaders will use to protect the air we breathe and ensure that our home planet remains an oasis of life in the vast expanse of space.

NASA's North Atlantic Aerosols and Marine Ecosystems Study (NAAMES) used measurements to clarify annual cycles of ocean plankton and their relationship with atmospheric aerosols.

Reaching Skyward to Study Weather, Climate

Scientists fly over the western Atlantic to study how air particles called aerosols interact with clouds. That cloud-aerosol relationship is one of the biggest uncertainties in predicting climate.

At NASA's Kennedy Space Center, the Mars 2020 payload fairing is prepared for launch. Inset photo: MEDLI2 sensors, seen here inside the spacecraft's heat shield, will measure conditions as Perseverance enters the Mars atmosphere.

Driving Success – Moon to Mars

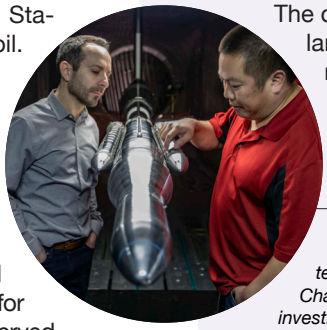
As NASA prepares for human exploration of deep space, Langley engineers, researchers and technicians shape bold ideas that will drive mission success and help make history.

Langley's work protects America's space pioneers — the men and women who will reach for new heights and reveal the unknown.

From left, Andy Greaves of Kyocera Corp; Karen Taminger, Langley researcher; and Andwele Grant with Commonwealth Center for Advanced Manufacturing; collaborate on work related to new spacesuits.

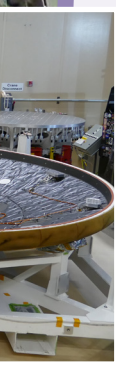
The Orion **Launch Abort System** (LAS), built to keep astronauts safe in the event of a mishap, cleared a hurdle when technicians successfully completed a final Attitude Control Motor (ACM) hot fire qualification test in early 2020. The ACM is now qualified for Artemis II. Set to launch in 2023, it will be the first crewed flight of the Space Launch System and Orion. The LAS program is managed at Langley.

In May, NASA and SpaceX successfully launched American astronauts to the International Space Station from American soil. Langley's **SCIFLI team** was there to help collect imagery and data.



Jeremy Pinier, Space Launch System (SLS) aerosciences technical quality lead; and David Chan, wind tunnel test principal investigator; inspect the SLS model inside the National Transonic Facility.

Langley sent **hardware to NASA's Kennedy Space Center** to support both Artemis I and II. A mass simulator for Orion, built at Langley, served as a stand-in for the Artemis I Orion spacecraft during tests. In September, Flush Air Data System sensors were delivered to measure atmospheric conditions on the Orion heat shield during re-entry of Artemis II, giving NASA data it needs to improve safety. The system is planned for use on future Artemis missions, too.



The **Lightweight Surface Manipulation System** team was selected by NASA's Game Changing Development program to build a full-size lunar crane for a Human Landing System.

Langley's knowledge of how to land spacecraft on other worlds is essential to the **Mars 2020 Perseverance** rover mission that launched in July. Center experts contributed entry, descent and landing modeling and simulations as well as parachute testing. The center also led the development of the Mars Entry, Descent, and Landing Instrumentation 2 sensor suite — MEDLI2 for short — on the capsule to collect data during landing. The data will help improve future landing technologies. Langley researchers also had a hand in creating the Mars 2020 Ingenuity Mars helicopter through fluid dynamics computer modeling.

Langley experts will play a pivotal role in another Mars mission. They've been tasked with building the Earth return capsule for the Mars Sample Return mission. Samples collected by Perseverance will be flown back to Earth as early as 2031.

Langley teams are also developing ways to shield astronauts from harmful space radiation. The agency tapped the center's capabilities to make parts for the **Artemis generation spacesuit**. On that project, Langley partnered with Virginia's Commonwealth Center for Advanced Manufacturing.

Lunar Landing Tech, Safer Cars

A sensor created to help astronauts make bull's-eye landings on the Moon could one day keep drivers safe as they zoom along America's highways.

From air taxis and autonomous cars to robotic missions on distant planets, the potential uses for the technology known as Navigation Doppler Lidar, or NDL, seem endless.

What could be a better proving ground than the Moon?

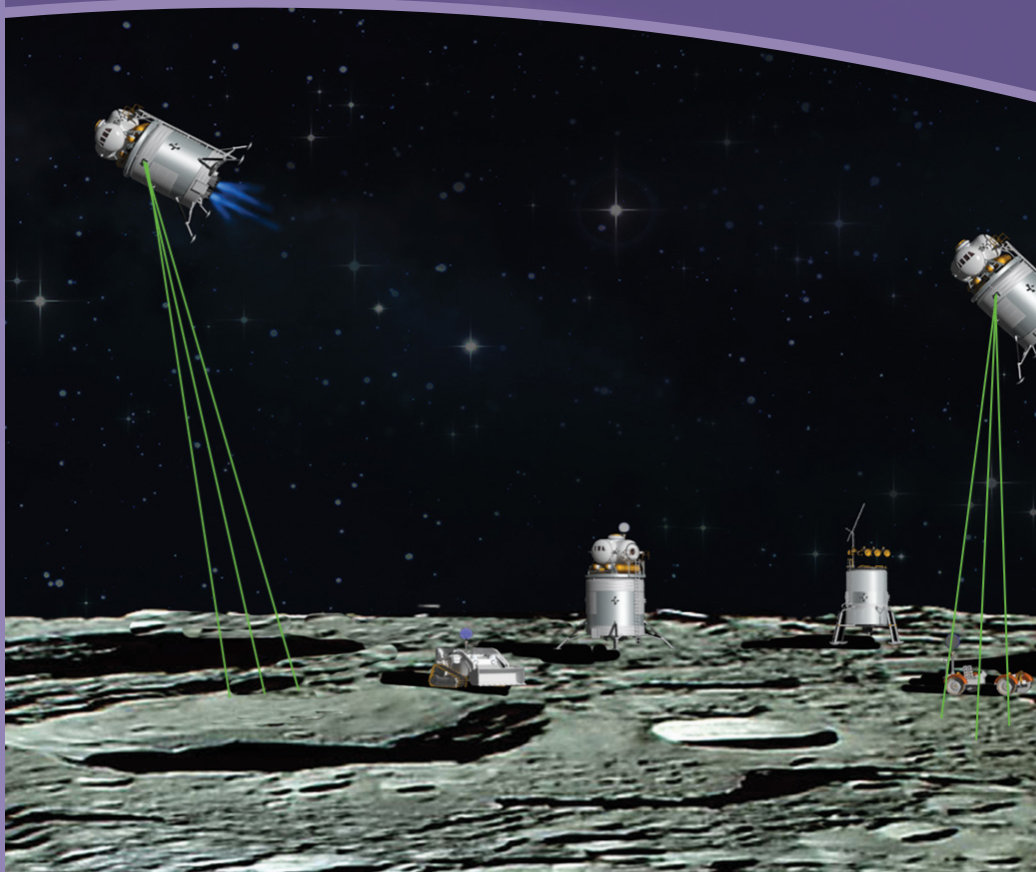
"We see Navigation Doppler Lidar as a key to successful lunar exploration," said David Dress, leader of Langley's Space Technology and Exploration Directorate. "It's one of the tools that will help the first woman and next man land safely and precisely on the Moon."

Here's how the system works. NDL uses a near-infrared laser to gather vital information — a vehicle's speed and distance with respect to other objects — more quickly and accurately than what's possible using more conventional technology.

Researcher Aram Gragossian prepares to test the range of a Navigation Doppler Lidar (NDL) unit as NDL Chief Engineer Glenn Hines, far right, and Principal Investigator Farzin Amzajerdian, left, look on.

Using light waves in the same way that radar uses radio waves, the system gathers precise data that tells how fast and at what angle the vehicle is moving toward its destination.

Precise landings are essential to NASA's plans for human exploration of both the Moon and Mars.



Technician John Savage removes a section of a Navigation Doppler Lidar unit that was milled from a block of metal.

"I am very excited and feel fortunate for the opportunity to contribute to space exploration and for having a small role in pursuit of better understanding of our origins," said Farzin Amzajerdian, a Langley researcher and co-inventor of the sensor. "I am also very excited about terrestrial applications of NDL here on Earth."

Auto manufacturers are interested in its potential as a safety technology. Steve Sandford, former engineering director at Langley, formed a company that in 2016 licensed NASA's Doppler lidar technology and entered into a Space Act Agreement allowing it to use agency facilities and expertise while developing commercial versions of NDL.

It's been a long road for this promising, versatile sensor. In the early 2000s, as NASA worked through landing challenges during the Mars Phoenix and Mars Science Laboratory missions, Amzajerdian saw the potential of augmenting radar navigation with lidar.

In 2004, his team got the green light to develop an NDL design concept and create a laboratory system to demonstrate it. In 2008, through a project called Autonomous Landing Hazard Avoidance Technology, or ALHAT, researchers tested an NDL unit on a helicopter.

From there, progress has accelerated.

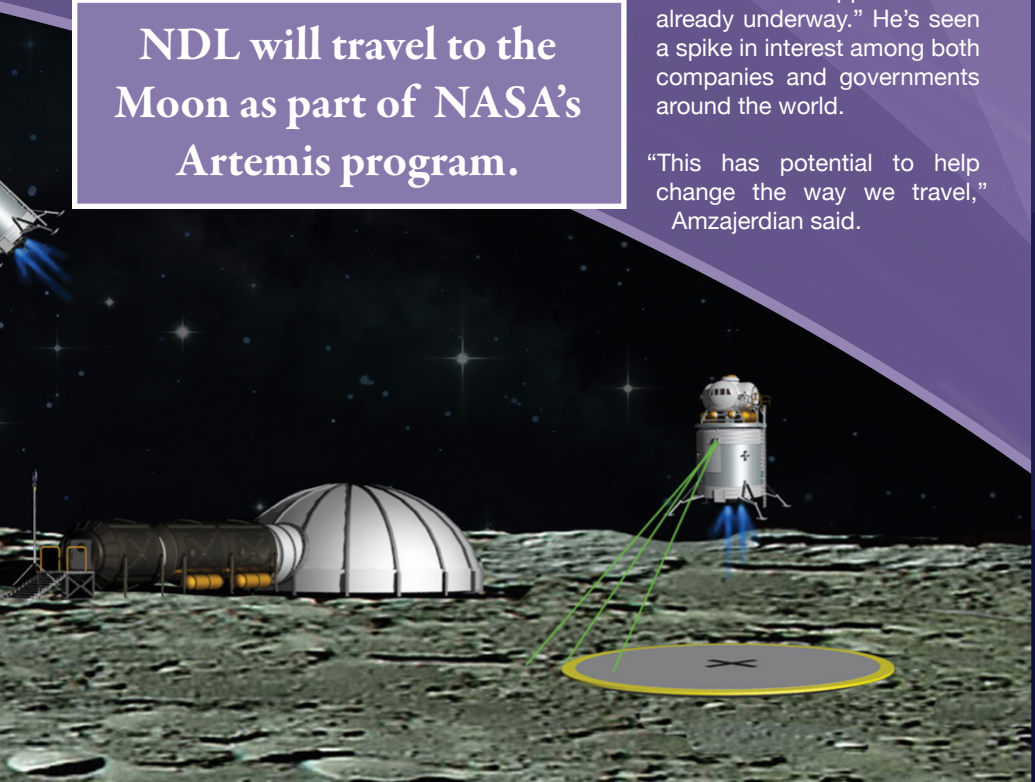
NDL has been successfully tested on various platforms including rocket-powered vehicles. Its latest trial came in October with the Blue Origin NS-13 New Shepard suborbital rocket launch. On New Shepard, NDL was part of NASA's Safe and Precise Landing — Integrated Capabilities Evolution, or SPLICE, technology suite. Another such flight test is set for 2021.

Also, NDL is scheduled to ride to the Moon on several commercial landers as part of NASA's Artemis program.

Amzajerdian believes that NDL — and technologies like it — will eventually touch the lives of people everywhere. "The NDL commercialization for autonomous vehicles and other applications is already underway." He's seen a spike in interest among both companies and governments around the world.

"This has potential to help change the way we travel," Amzajerdian said.

NDL will travel to the Moon as part of NASA's Artemis program.



Practicing for the Next Moon Landing

NASA Langley built a simulator called the Lunar Flight Deck to help researchers developing the cockpit of the Human Landing System. The HLS is the vehicle that will shuttle astronauts to the Moon's surface.

New technologies will save lives, protect the environment and boost the American economy.

Shaping the Future of Flight

NASA is with you when you fly — and working hard to lift you toward a more mobile future.

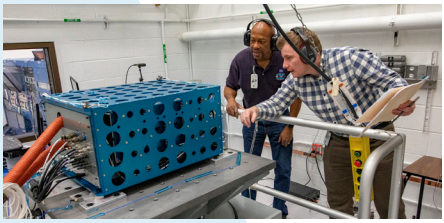
Advances at Langley will lead to faster aircraft and more capable drones. New technologies being explored will save lives, protect the environment and boost the American economy.

In pursuit of cleaner aircraft for a greener planet, NASA's Advanced Air Transport Technology project examined a **high aspect ratio wing**. Replacing the conventional wing of a transatlantic business jet with one that's larger and braced is seen as step toward a more fuel-efficient airplane.

Someday, autonomous drones will deliver packages to your doorstep and you'll summon a pilot-less air taxi to whisk you across town. Langley accelerates the safe, widespread use of autonomous drones through projects such as the **Unmanned Aerial Systems Traffic Management** and the **Unmanned Aircraft Systems in the National Air Space**. Langley is laying the groundwork for a thriving ecosystem of aircraft piloted by man and machine.

Autonomous flight research will strengthen the nation's critical infrastructure — protecting everything from telecommunication systems used for your cell phone to the country's electrical grid. In 2020, Langley teamed with the U.S. Department of Transportation to test new positioning, navigation and timing systems that could serve as a **GPS backup**. The positioning system GPS is vital to a list of systems we use every day, from Google Maps to digital banking. The federal government has made finding a backup system a national priority.

These backup systems are essential for autonomous aircraft to fly in cities.

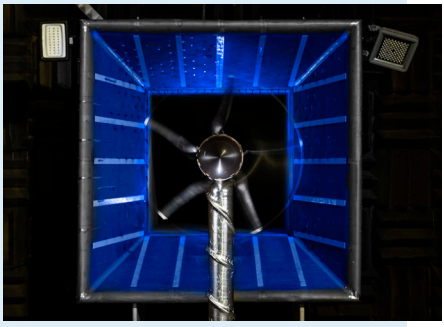


Researchers Larry Cowen, left, and Matthew Miser inspect the X-59 QueSST's eXternal Vision System as it rests on a vibration platform.

Also, a Langley team set out to prove that artificial intelligence and autonomous aircraft can save lives through search-and-rescue missions. The Autonomy Teaming & Trajectories for Complex Trusted Operational Reliability, or **ATTRACTOR**, project represents a step toward the day when drones — even personal aerial vehicles — fly anywhere.

If an autonomous aircraft is to ever deliver packages to your home, it should be quiet enough not to wake a sleeping baby or drown out a Sunday football broadcast. A set of Revolutionary Vertical Lift Technology tests conducted with the U.S. Army were part of a move to soften the buzz of drones.

How would you like to fly from the East Coast to the West in half the time it takes now? NASA pushes closer to that vision with the supersonic **X-59 Quiet SuperSonic Technology** (QueSST) aircraft currently being assembled in California. Researchers are preparing to measure public response to the softer "sonic thump" that will be created by this experimental aircraft.



Propeller technology for NASA's first all-electric X-plane, the X-57 Maxwell, being tested in the Low-Speed Aeroacoustic Wind Tunnel.

A Cleaner Way to Fly

To protect the air we breathe, NASA wants you to soar through the skies in an airliner that's greener, cleaner and cheaper to operate.

That's the goal of research being conducted at Langley and across NASA with help from industry partners.

> *"The Transonic Truss-Braced Wing has me very excited about the future of aviation"*
>
> — NASA Administrator Jim Bridenstine

A novel aircraft design called the Transonic Truss-Braced Wing (TTBW), tested in Langley's 14-by 22-Foot Subsonic Tunnel, is among several new, more efficient aircraft shapes cruising ever closer to the marketplace.

While contours of commercial planes have remained relatively static for decades, change is on the horizon.

"It really makes the upcoming decade special," said Langley's Rich Wahls, advisor to the NASA Advanced Air Vehicles Program. "In this decade we plan to take the most promising ideas to high-fidelity demonstration to give technical and business leaders in industry the confidence they need to make a jump."

Tests at Langley are the latest step in a years-long collaboration between Boeing and NASA on the Transonic Truss-Braced Wing. The design's longer, thinner, more aerodynamically efficient wings — supported by struts — decrease drag. That translates into less fuel burned and fewer carbon emissions.

Boeing's Transonic Truss-Braced Wing (TTBW) concept is designed to fly higher and faster than previous designs. Image courtesy of Boeing

Researchers predict fuel savings as large as 9% compared with an advanced technology conventional aircraft.

More work is needed to prove this new design is ready for the flying public. It must meet the same certification standards as traditional ones.

Still, encouraging signs abound.

The Langley tests confirmed that an airplane with the TTBW design could take off and land safely. The project was described as the first high-lift integration, low-speed test of a Transonic Truss-Braced Wing design. "It all looks very promising," Wahls said.

NASA Administrator Jim Bridenstine agrees.

"The Transonic Truss-Braced Wing has me very excited about the future of aviation," Bridenstine told the U.S. Senate Committee on Commerce, Science and Transportation in September 2020.

Bridenstine acknowledged COVID-19's impact on airlines. Even in a difficult environment, he said, America must continue to lead in aeronautics innovation.

"The Transonic Truss-Braced Wing is a key to that leadership," Bridenstine said.

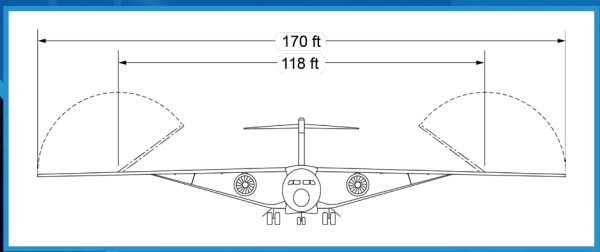
NASA and industry partners have explored many nontraditional aircraft designs.

The truss-braced wing design, though, proposes a more familiar shape while delivering substantial benefits — a combination attractive to aircraft manufacturers.

"It has their interest — and the interest of others around the world," Wahls said. "The beauty of it is that it's a less radical change than some, which means there's a better chance of seeing it implemented."

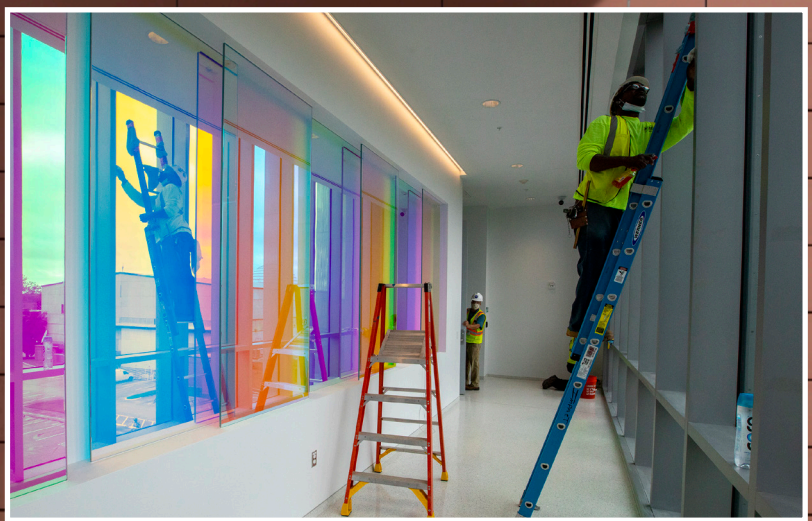
Could a Transonic Truss-Braced Wing aircraft make airline tickets cheaper? It's hard to say.

"But it would definitely put less carbon in the air," Wahls said. "With the truss-braced wing, the substantial benefit comes in lower energy use."



Keeping You Safe in a New Era of Flight

NASA Langley has created an unmanned aircraft called the Langley Aerodrome 8, or LA-8 for short. Researchers use it to test Urban Air Mobility technology. The goal is keeping passengers safe in a world where skies are abuzz with new electric aircraft.



Langley's first new lab in decades, the 175,000-square-foot Measurement Systems Laboratory, was constructed in 2020. Here, workers apply finishing touches to the facility where researchers will develop and test revolutionary sensor technologies.

Tomorrow's Ideas Today

Innovation at Langley protects lives, encourages efficient use of tax dollars and has potential to inspire improvements across the federal government.

From a high-tech method for monitoring center access to a state-of-the-art lab for creating ground-breaking sensor technologies, new ideas implemented in Langley's workplace will have far-reaching impact.

In the midst of the COVID-19 pandemic, many behind-the-scenes workers and innovations at Langley kept missions moving. A novel **Project Access Selection System** application uses Geospatial Information Systems to help personnel safely return to on-site work. With it, project managers request access to buildings and rooms across the center on specific dates for approved reasons. The system tracks requests and simplifies the process of assigning crews to clean and sanitize the spaces.

Imagine an ultra-efficient approach to data reporting and communication, one that replaces the need for time-consuming presentations and clunky desktop templates. Built with lessons from pilot projects and planned for wider use, a web-based **Open Project Management** system promotes efficient decision making. As use expands, the team plans to develop a set of dashboards and cloud-based storage platforms.

NASA innovations strengthen the economy and create jobs. Creatively engaging with small businesses, commercializing technology and developing partnership opportunities was the goal of the **Safeguard with Autonomous Navigation Demonstration** (SAND). This pilot project was designed as a competition through which small businesses would use an existing patented NASA technology — in this case, an unmanned aerial vehicle safety technology called Safeguard. While the 2020 competition was indefinitely postponed due to COVID-19, Langley leaders plan to use the SAND approach as a model in years ahead.

Crews constructed the **Measurements Systems Laboratory**, or MSL, Langley's first new laboratory in decades. This 175,000-square-foot facility for developing, testing and implementing sensor technologies represents the Langley of tomorrow. Designed for collaboration and agility, it's where researchers will advance technologies for self-driving cars, autonomous aircraft, study of weather and climate, and human space exploration.

Due to COVID-19, researchers used a virtual control room at Langley to direct a composite material shell buckling test at NASA's Marshall Space Flight Center. Left to right, Kyongchan Song, Marc Schultz, Nate Gardner and Cyrus Kosztowny.

Researchers in the MSL will be able to operate three laser-powered lidar systems simultaneously, expanding Langley's rapid testing. The building's fifth floor allows lidars to reach distant targets for long-range testing and calibration.

Breakthroughs that happen in the MSL will elevate the economy — and the American people — for decades to come.

Intelligent Tech, Rapid Results

A project called SmartLab seeks to lead Langley's transformation into a cyber-physical research center, one capable of quickly turning data into discoveries.

Put simply, the SmartLab approach would help smart people change the world.

The SmartLab team includes, from left, Mia Siochi, Matthew Bartgis and Ben Jensen.

Through the project, researchers and software developers work together to accelerate research workflow by creating efficiencies in data collection, tracking, processing and visualization.

The goal is to keep the focus on drawing knowledge from the river of data produced by experiments and tests. The team is pushing the envelope of efficiency within federal laboratories.

"SmartLab revolutionizes the way we perform research experiments, manage and share data, and it will enable us to efficiently perform research and collaborate with our partners in the future," said Kevin Rivers, Langley's associate center director for technical.

The network connects researchers and engineers across disciplines so that the new software tools are adaptable throughout laboratories, wind tunnels, clean rooms and unmanned aircraft systems field experiments.

SmartLab's Godfrey Sauti said the project could speed problem solving. "The more efficiently researchers can solve problems, the more it benefits those who are exploring the Moon and Mars."

Now in a pilot phase, the project has developed and deployed tools that enable labs to automate data gathering and use QR codes to track samples and

SmartLab

"The more efficiently researchers can solve problems, the more it benefits those who are exploring the Moon and Mars."

— Godfrey Sauti, SmartLab leader

assets. Other tools for data processing and visualizations show the capabilities and benefits of connected research.

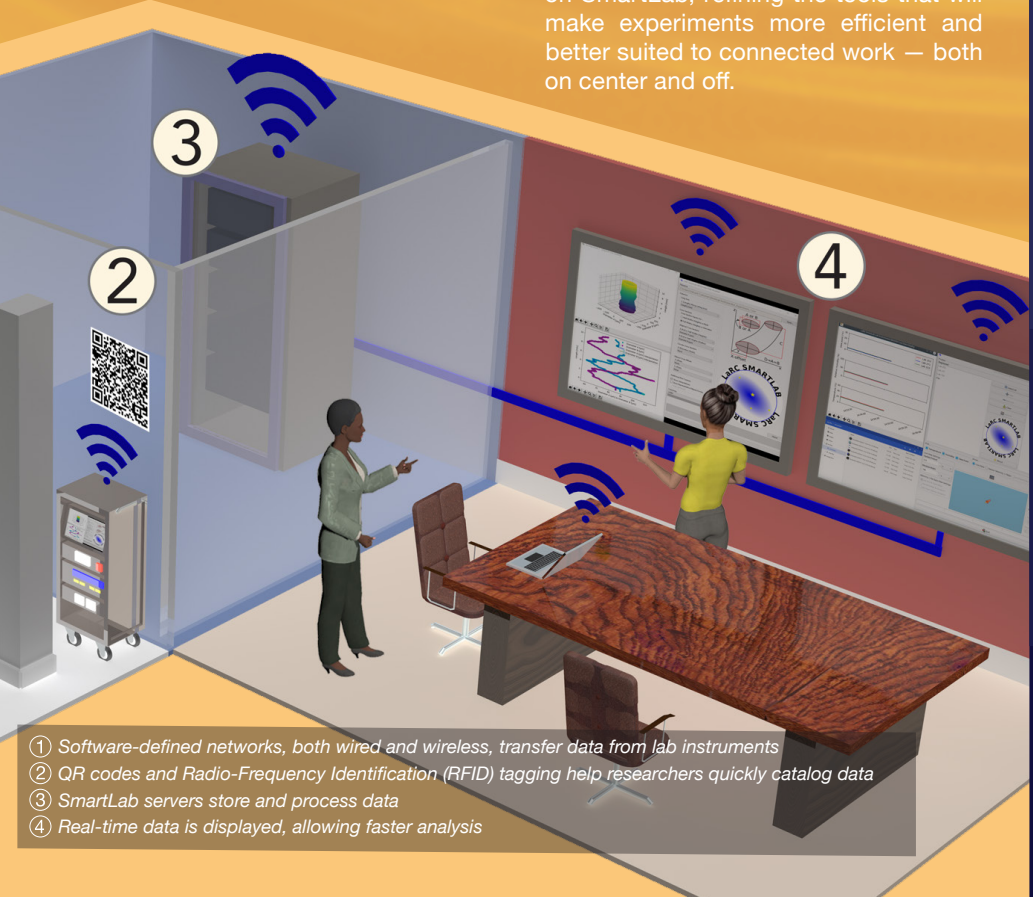
To maintain secure communications across connected instruments and seamless integration with facilities, SmartLab uses what's called a Software Defined Network infrastructure. It connects instruments without compromising security in facilities such as the center's new Measurements Systems Laboratory where transformational sensor technologies will be developed.

"If fully implemented, the efficiencies that we could get in conducting research and managing data could be a major benefit to the mission," Sauti said.

While the team continues to develop a unified data management application, it has released a set of tools for researchers to use. They include applications that monitor laboratory environments, track lab and office assets and process and visualize experimental data.

An integrated team of software developers and researchers are working to merge capabilities offered by the standalone applications and other new features into an integrated web-server-based platform, making simplicity and user friendliness a priority.

As COVID-19 kept some researchers away from their labs, software developers worked remotely and collaboratively on SmartLab, refining the tools that will make experiments more efficient and better suited to connected work — both on center and off.



① *Software-defined networks, both wired and wireless, transfer data from lab instruments*
② *QR codes and Radio-Frequency Identification (RFID) tagging help researchers quickly catalog data*
③ *SmartLab servers store and process data*
④ *Real-time data is displayed, allowing faster analysis*

Embracing New Ways to Work

Langley researchers and support personnel describe the spirit and benefits of the center's transformation efforts.

Transform

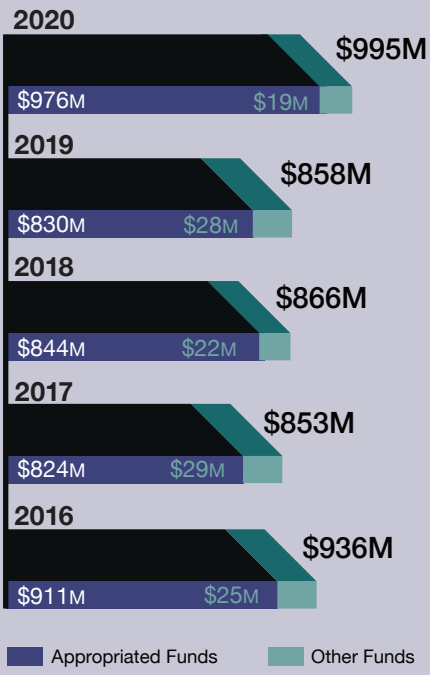
Economic Impact

Your Tax Dollars at Work

In Virginia, NASA generated an economic impact of

$2 BILLION LABOR INCOME | **$5.5 BILLION** ECONMIC OUTPUT | **27,097** JOBS

Langley Funding



NASA contracts sourced in Virginia totaled

$1.6 BILLION

NASA activities in Virginia generated

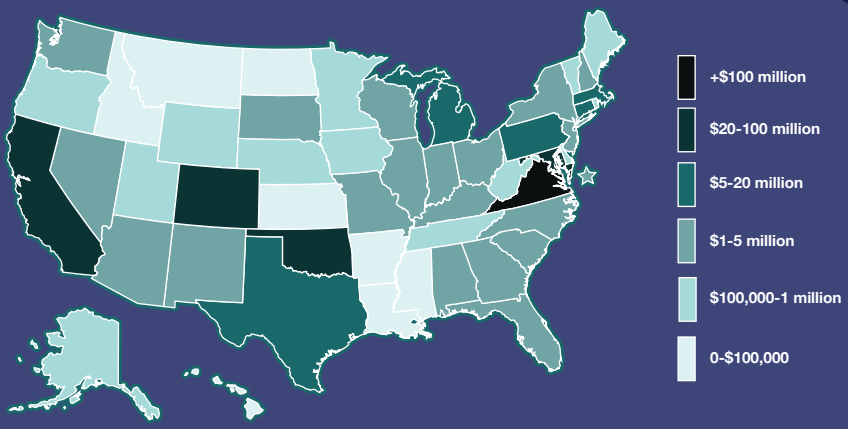
$219.9 MILLION

in tax revenues for Virginia state and local governments

**As calculated by an agency-wide University of Illinois at Chicago study, based on fiscal 2019 numbers*

Langley Spending

(by state)



Inspired Minds, New Heights

Great things happen where inspiration and education meet. To make those connections, men and women of Langley share their passion for science, technology, engineering and math — known collectively as STEM.

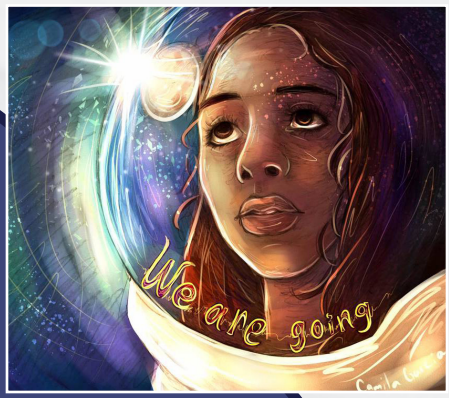
When COVID-19 required Langley to rethink engagement efforts, creativity ramped up quickly. That spirit continues today as staff members look for ways to encourage explorers and scientists of tomorrow.

Lindsay Thornton, Langley senior education specialist, hosted STEM-related videos broadcast online and on a Virginia PBS affiliate.

Langley's STEM professionals shifted gears to produce content for the **NASA STEM at Home** initiative. That effort yielded activities on subjects including the Artemis and Mars 2020 Perseverance missions and NASA legend Katherine Johnson, who died in 2020 at age 101.

Langley also produced videos for PBS TV and NASA radio affiliate VPM in Richmond, Central Virginia and the Shenandoah Valley for students without internet access.

Staffers pivoted to other virtual education efforts and re-imagined events for an online audience. The center's annual **Youth Day** for children of center employees took place as a virtual event. The center presented a GIS (geographic information system) webinar for college students and virtually hosted more than 300 interns during summer and fall.



Camila Garcia's prize-winning self portrait. Garcia is a tenth grader in North Bergen, New Jersey.

NASA's Minority University Research and Education Project, MUREP, engages with underrepresented populations, partnering with offices across the center and beyond. Before the pandemic, Langley hosted students from community colleges and kicked off an effort with NASA aeronautics to engage faculty and students at minority serving institutions in high-volume manufacturing.

In July, Langley and NASA's Wallops Flight Facility joined Virginia Commonwealth University to present a professional development class for teachers. Also, **MODSIM**, a workshop for math teachers offered with Radford University, began virtually — giving Virginia teachers access to experts and materials supporting math lessons.

Langley helps the agency inspire youth through **NASA STEM STARS**, a series of webinars connecting K-12 educators and families with NASA experts.

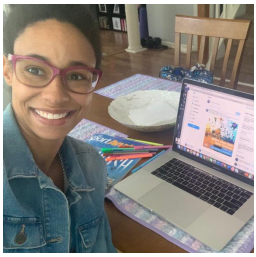
The annual **student art contest**, run by Langley, attracted a record 1,277 submissions from 40 states and Puerto Rico. The theme, "We Are Going," highlighted NASA's plans to return to the Moon and press on to Mars. Camila Garcia took the grand prize. "Inspiration for my artwork was simply the idea of things being reachable," she said.

Video

Lessons that Resonate

In the "Zoom Minus Boom" episode of the NASA at Home video series, Langley staffers show us how the agency is helping to quell the sonic boom so that commercial air travel can become faster for everyone.

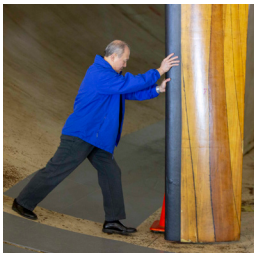
STEM

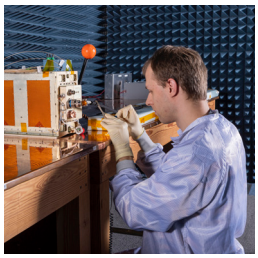




Our People

Langley's 3,500 civil servants and contractors come from diverse backgrounds and unite behind one goal: creating excellence to drive NASA success.



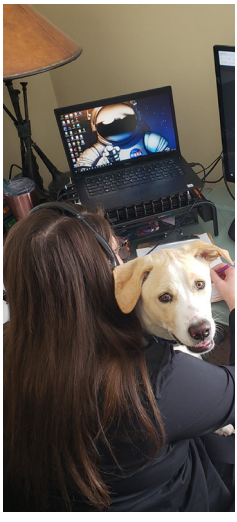



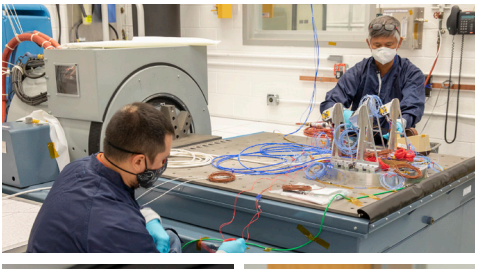


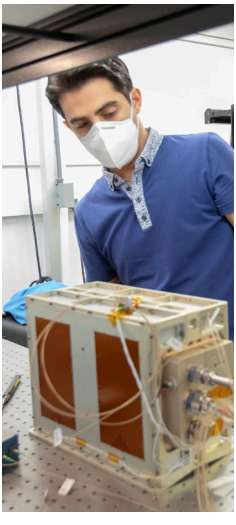









Our People

Video

Our People

Meet two of the many remarkable people who make a difference every day at NASA's Langley Research Center.

Beth Rieken

Som Dutta

Stay connected. Big things are on the way.

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