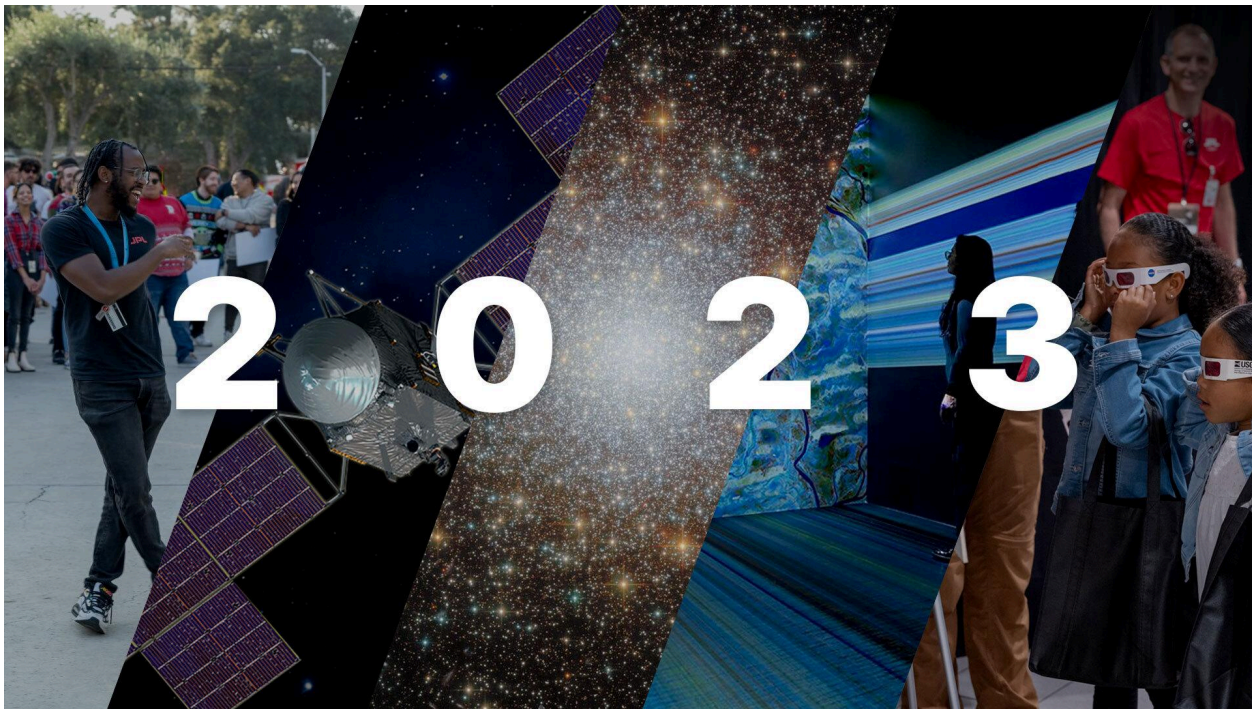
universe

JPL

January 2024

Featured Stories



A Year of Change for JPL

By Carl Marziali

Director Laurie Leshin and the Executive Council began to unveil signature initiatives of her tenure in 2023:

- A three-year Plan for JPL to address immediate needs and position the Lab for the long term
- A new set of JPL Values: Bold, Inclusive, Trusted
- Responses to independent reviews of Psyche and Mars Sample Return
- The Lab's first diversity, equity, inclusion, and accessibility strategy
- Appointment of the first ombuds since 2010

The initiatives reflect a common set of priorities, which Leshin calls her North Star — one she returned to at the start of every town hall and in her introduction to the Lab's three-year plan:

- Drive the forefront of scientific discovery and extraordinary benefit to humanity through innovative missions, technology, and research
- Inspire people everywhere to think bigger and imagine what is possible
- Leverage our unique capabilities to advance the broader space-exploration ecosystem
- Create a safe, inclusive, exciting workplace where all can thrive

Accordingly, this annual recap is organized by the four priorities in reverse order, starting with events for the JPL community and public, and ending with the year's mission highlights by directorate.

Creating a safe, inclusive, exciting workplace where all can thrive

In addition to the launch of JPL's first DEIA strategy, led by the Office of Inclusion, and the restoration of the ombuds office, the Lab hosted community-building events such as the all-personnel "Holiday on the Arroyo" celebration on Dec. 6, and the annual Halloween costume and JPL birthday party, which this year included free Values lanyards, coasters, and stickers.

The Lab also hosted its first open house in more than three years, welcoming thousands of space fans to **Explore JPL** the weekend of April 29-30, with the help of hundreds of JPL employees recruited and managed by the Public Services Office in the Communications and Education Directorate (18x).

Leshin, Executive Council members, and other JPLers mingled on the Mall at two Welcome Tables in 2023, including one in May in honor of Director Leshin's first anniversary at the Lab. Designed to promote connection through its unbroken length, the Welcome Table is scheduled to return in January for a celebration of the Mars Exploration Rover's 20th anniversary.

The Lab looked back at its origins as well, taking stock of its founding story and completing the historical record. Lab Engagement and the Office of Inclusion led an effort to update the monument known as the **Founders' Plaque** near the entrance to Lab. An overlay made of glass — chosen to symbolize transparency and to preserve the original inscription — lists contributors omitted when the bronze monument was cast in 1968: theoretician Qian Xuesen, funder and photographer Weld Arnold, and observer Jeanne Bollay.

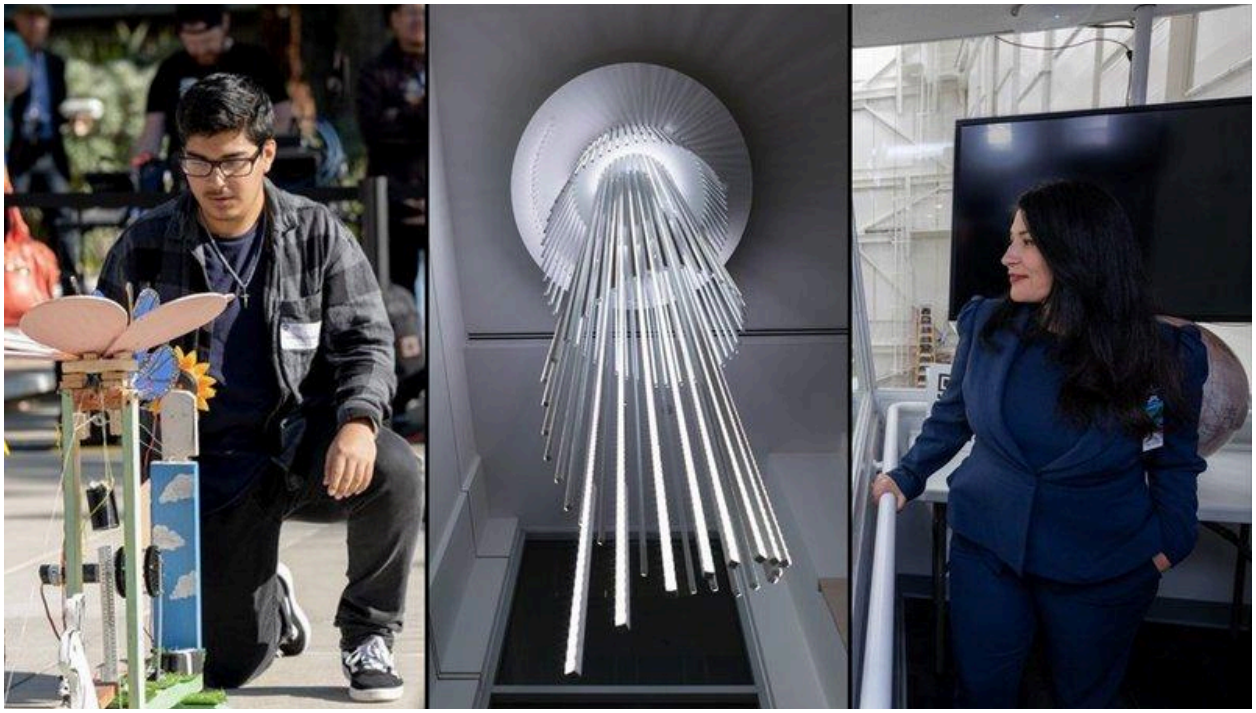
Speaking of Xuesen, a JPLer at the May 23 unveiling said: “For the Asian American community, it’s amazing to have his contribution included, this part of history recovered, and the truth restored.”

Leverage our unique capabilities to advance the broader space-exploration ecosystem

The future of space exploration was in plain sight on the Mall on a recent day. The annual **Research Poster Day** brings out futurists from every corner of Lab, and features studies funded by the Research and Technology Development and the Strategic University Partnership, as well as work from JPL post-doctoral researchers. The 2023 edition, held Nov. 29, added posters from JPL’s Blue Sky Studies program. The in-house think tank to explore revolutionary mission concepts marked its 10th anniversary this year.

At the event where he once presented his own posters, Chief Technologist Tom Cwik said: “You look back over the past years of research that’s come out of these poster sessions, and you see pieces of technology used in the autonomous rovers known as CADRE that we’re sending to the Moon in March next year. That work was in these posters five, 10 years ago.”

Other activities, if less physically visible, are no less important. JPL also drives innovation through the **JPL Next** investment program for new system concepts, and through technologies tested on the current generation of missions, such as optical detectors created by the Microdevices Laboratory for tracking mineral dust transport; the Mars 2020 Sample Caching System on Perseverance; and a new generation of single-photon detectors serving as receivers for the Deep Space Optical Communications experiment.



Inspire people everywhere to think bigger and imagine what is possible

When NASA Administrator Bill Nelson dreamed of building a “mission control” center for Earth, JPL made it so. The **Earth Information Center** in the public lobby of NASA’s D.C. headquarters opened in June, featuring real-time Earth science and climate data in an immersive design that lets visitors engage with Earth’s vital signs. JPL partnered with NASA and Goddard Space Flight Center on the EIC, with a DesignLab team in Lab Engagement developing the Earth Pulse sculpture, the hyperwall, the “Space for Earth” experience, the “Eyes on Earth” kiosk, and the 16-foot red NASA worm logo outside the lobby doors.

Upgrading the agency’s virtual lobby, another DesignLab team — also working with NASA and Goddard — led a comprehensive **upgrade of NASA’s web presence**, gathering sites under one architecture and

migrating all content into a JPL-configured management system. The flagship nasa.gov and science.nasa.gov domains launched in September.

JPL supported hundreds of interns through programs in the Education Office and Human Resources. Student teams came to Lab for a range of contests, from the Ocean Sciences Bowl and the 22nd annual Los Angeles FIRST Robotics competition, to the home-grown Invention Challenge, in which high school teams and JPLers compete to accomplish a specified engineering task.

JPL's Media Relations and Public Engagement teams supported multiple missions, including the October launch of Psyche to a metal world and the feats of JPL's robotic explorers on Mars. The Perseverance rover collected several samples from an ancient river delta, and the Ingenuity helicopter completed nearly half of its more than 60 flights in 2023.

To inspire people everywhere is difficult yet routine at JPL. But to inspire poets? In a first for the Lab, the Public Engagement team enlisted the nation's **24th U.S. Poet Laureate, Ada Limón**, to serve as the public voice for Europa Clipper's Message in a Bottle campaign. Limón wrote "In Praise of Mystery: A Poem for Europa" exclusively for the mission. She presented the poem at the Library of Congress in June, and its words — along with the names collected for the Message in a Bottle campaign — will be engraved on the spacecraft before Europa begins its journey toward the Jupiter system in 2024.

Drive the forefront of scientific discovery and extraordinary benefit to humanity through innovative missions, technology, and research

Astronomy and Physics

- The **Coronagraph Instrument** on the Roman Space Telescope, the most sensitive tool in NASA's mission portfolio for direct imaging of exoplanets, completed assembly in 2023 and entered functional testing. This technology demonstration combines masks, prisms, detectors, and self-flexing mirrors to shield the glare from stars and reveal the planets in orbit around them. CGI is expected to enable the first direct imaging of Jupiter-size exoplanets, and to serve as a stepping stone to future instruments capable of imaging rocky planets such as Earth. The telescope is expected to launch in 2027.
- The **SPHEREx Observatory** payload was completed in 2023, with integration, testing, and systems integration review scheduled to occur by the end of the year. SPHEREx will conduct the first survey in optical and near-infrared wavelengths of the entire night sky, collecting data on more than 300 million galaxies and 100 million stars in the Milky Way, our home galaxy.
- A surveyor of the unseen universe, the **Euclid** mission to investigate dark matter and dark energy launched in 2023. JPL contributed the infrared flight detectors for one of Euclid's instruments, and the data and science analysis supporting U.S. investigators takes place at Caltech's Infrared Processing and Analysis Center. The European Space Agency leads the mission.
- JPL researchers using the **Cold Atom Lab** on the International Space Station achieved a fundamental advance in quantum physics when they created two species of quantum gases that coexisted and interacted for the first time in space. The JPL team simultaneously produced gases of rubidium and potassium in a uniquely quantum, wave-like phase of matter called a Bose-Einstein condensate. Studying interactions among these gases will allow scientists to explore quantum chemistry and fundamental physics without the perturbing force of gravity, which would cause the condensates to fall apart almost instantaneously.
- Launched in October on Psyche, the **Deep Space Optical Communications** experiment is demonstrating record distance and data rate performance at 267 Mbps from a distance of 0.2 AU or approximately 18 million miles. In a single pass, DSOC downloaded more than 1Tb of data, the equivalent of 20% of the entire data volume of Cassini's 20-year mission.

Earth Science and Technology

- Images and data from **Surface Water and Ocean Topography**, a collaboration between NASA and the French Space Agency, are already exceeding expectations. The orbiter scans over 90 percent of the planet every 21 days, measuring 95 percent of the world's lakes larger than 15 acres and rivers wider than 330 feet, and allowing researchers to better understand how climate change is affecting the planet's water cycle.
- **Earth Surface Mineral Dust Source** is tracking Earth's airborne mineral dust transport as expected. Also as expected, EMIT's spectrometer can detect greenhouse gases, particularly methane. What was not expected was the instrument's extraordinary sensitivity to methane emissions, from tens of thousands to just hundreds of pounds per hour. Within weeks of entering orbit, EMIT had become a "super-emitter" detector. It has already identified over 750 point-source emissions, including from landfills, agricultural sites, and oil and gas facilities.
- NASA and the Indian Space Research Organisation are readying the **NASA-ISRO Synthetic Aperture Radar satellite** for launch in 2024. NISAR will scan Earth's surface every 12 days observing the most complex natural processes of our planet, including ecosystem changes, the movements and melting of glaciers and sea ice, and the motion of landforms to better understand earthquakes, volcanic eruptions, and landslides. NISAR marks the first time the two space agencies have collaborated to develop an Earth-observing mission.

Interplanetary Network Directorate

- The directorate's **Deep Space Network** already returns pristine data across the vastness of space, and a coming leap to laser transmissions will greatly increase communication bandwidth for human and robotic missions.
- Developed with the Astronomy and Physics Directorate, **DSOC** is expected to revolutionize transmissions between Earth and deep space over the DSN, achieving high-rate transmissions over as far as 240 million miles – well beyond the average distance to Mars, and more than enough to provide two-way high-definition communication to future explorers on the Red Planet.
- The past year was also memorable for a **grand tour** by NASA's Deputy Administrator Colonel (USAF, Ret.) Pamela Melroy. She visited all three DSN locations in the U.S., Spain, and Australia, walking amongst the giant antenna dishes that support all of NASA's human and robotic missions.
- Melroy learned of upcoming DSN improvements to support human exploration on the Moon and robotic ventures ever farther in space. One of those improvements, a new 34m (112 feet) antenna for the Goldstone site in California, was fully assembled in 2023 and will travel to its final location next year.

Planetary Science

- The Planetary Science directorate — and the entire Lab — cheered the flawless takeoff and operation to date of **Psyche**, free of the technical issues that postponed its original launch date in 2022. Scheduled to arrive at the metal asteroid in August 2029, Psyche will orbit at different distances – coming as close as 47 miles – to probe the structure and composition of the closest known analogue to a planet's exposed core. Psyche also will pilot two technologies for possible use in future missions: electric propulsion, in which the spacecraft uses solar power to excite and accelerate a stream of xenon gas, and laser beams to increase data bandwidth (see the Interplanetary Network section above).
- On Mars, **Perseverance** continued caching samples for eventual return to Earth, and the **Ingenuity** helicopter — originally planned for a five-flight demonstration — has logged 67 to date.
- Europa Clipper is sailing toward launch in October 2024, from the Kennedy Space Center in Florida. Once at Jupiter's moon, Clipper will fly past Europa nearly 50 times, coming as close as

16 miles from its icy surface to study the frozen crust and its subsurface ocean, warmed by tidal forces and believed hospitable to life.

- The next great mission to search for traces of ancient life, **Mars Sample Return**, underwent its second independent review in 2023. In its report to NASA in September, the review board noted the scientific importance of the mission but expressed concerns over the mission's budget, among other areas. In response to the report, NASA set up a response team led by Sandra Connelly, NASA's deputy associate administrator for science. NASA plans to make a recommendation by the second quarter of fiscal year 2024 regarding a path forward for the mission. Mars Sample Return would fulfill one of the highest-priority solar system exploration goals identified by the National Academies of Sciences, Engineering and Medicine in the past three decadal surveys.

Ryan Smernoff, Paul Propster, and Taylor Hill contributed to this recap.

From Art to AI: The Duality of an Inspired Mind

By Vincent Robbins

When Bradley Gay moved to California last year for a new job at JPL, his mom gave him several boxes from decades past. Inside one, he found a half-page essay from fourth grade about the tundra, accompanied by drawings he had sketched in third grade.

Growing up, Gay loved writing about the characteristics and creatures of the tundra's permafrost, as well as drawing wildlife — a recurring theme throughout his childhood that underscored his fascination with both art and science.

While some might pick one career path or the other as an adult, Gay made no compromises. Today, he is an Arctic scientist with a Ph.D. in Earth systems and geoinformation sciences, a degree he pursued after a five-year hiatus as a professional artist. Along his untraditional path, Gay harnessed a range of creative tools — from acrylic paint to artificial intelligence — that helped him bring his ideas to life.

“The recurring trend was that I wanted to be an artist and a scientist when I grew up,” Gay says. “I was in tears [looking through that box] because it’s kind of like everything was converging and working out.”

From Science Labs to Art Studios

Gay grew up in Nebraska and Japan, earning his bachelor's in biology from the University of Nebraska, followed by a master’s in environmental science and policy from Johns Hopkins University. This academic track landed him a job in Washington, D.C. working on power markets and environmental policy for the Climate Institute, APX, Inc., and the World Wildlife Fund.

“I thought that going into policymaking — going up on the Hill and trying to enact real change — would be of use to me and the community,” Gay says.

But after a few years, he grew frustrated with the bureaucracy and transient political administrations that he felt wouldn’t commit to significant environmental policy changes. Disillusioned and unsure of his chosen career path, Gay took a sabbatical to pursue his other passion: painting.

In 2015, he secured an artist residency for a few weeks in Joshua Tree National Park. The opportunity kicked off a prolific five-year stretch of intense focus on painting and visual art.

“I had a small quad-studio space in D.C. and I worked nonstop,” Gay remembers. “I ended up showcasing a lot of my stuff up and down the Atlantic coast, from Chelsea to Miami, and fortunately met some patrons along the journey. Those partnerships were essentially funding [my art] and allowed me to dedicate more time to create and explore new ideas and materials.”

While he had no formal training or fine arts degree to flex, Gay did have one advantage — a methodical, almost scientific process. He approached his foray into art the way he would a research project, carefully experimenting with different media, learning color theory, visiting museums and exhibitions, and studying photography.

“Admittedly, the lack of a traditional art education and formal training was an ego-deflating factor in the beginning,” Gay recalls of his first time exhibiting alongside graduates of prestigious art schools.

But as time progressed, he continued to produce and exhibit at local art centers, group residencies, national expos, solo shows, and private galleries, becoming more confident along the way in presenting his work and methodology.

Gay’s artwork typically starts with charcoal and acrylic paint, but is not limited to these media. He experiments with other materials, tools, and found objects, building and mixing arrangements with no set plan or process to express a complex vision or emotion on the canvas.

“A lot of the paintings are essentially 10-15 paintings on top of each other,” Gay says. “When I started experimenting with different media, I would actually tug and pull and rip and burn and do all sorts of different things to the pieces.”

The artistic inspirations and themes in his work are multi-faceted. When speaking about what influences his craft, he cites inner turmoil; light, shadow, and wind; despair and hope; perception and memory.

But it's his observations of Earth — its beauty, destruction, harmony, and systems — that resonated with him deeply and ultimately brought his love of science back full circle.

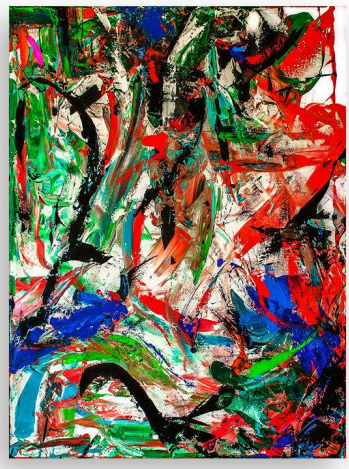
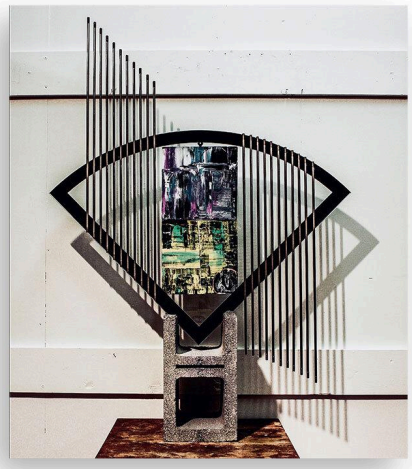
Tugged Away, Pushed Back

In 2019, Gay traveled to France and Spain to walk the Camino de Santiago de Compostela — an ancient, weeks-long pilgrimage trail — in search of perspective on his career path. Like anything that becomes a full-time pursuit, creating began to feel like work for Gay.

Toward the end of that pilgrimage, wildfire smoke filled the air just outside the mountain village of O Cebreiro.

"I started to think about the Earth system and how everything works in harmony — there has to be a cause and effect, a tug and push that occurs," Gay says. "I was really interested in figuring out how not only these Earth system dynamics work in harmony, but also how the Earth system remembers."

Gay cites this moment as the catalyst for pursuing his Ph.D. His frustration with policy had caused him — tugged him — to retreat into his art, but his passion for understanding the natural world had pushed him back to science. His career arc, oscillating between art and science, would come to resemble the harmonious cause-and-effect systems that he long found fascinating.


He entered an Earth sciences and geoinformation sciences Ph.D. program at George Mason University with an advisor specializing in wildfire dynamics and soil moisture memory. During this time, Gay saw an opportunity to amalgamate different types of data — field collection, remote sensing, process-based models — in a coherent, sophisticated format to better understand what changes were happening to Arctic permafrost systems over time. To accomplish this — while working as an ABoVE intern at NASA's Goddard Space Flight Center and completing his Ph.D. thesis, Gay turned to another creative tool that had piqued his fascination: artificial intelligence.

"[I was tasked with] developing and validating a permafrost module for a process-based model," Gay says. "But the fusion of process-based modeling, remote sensing, my long love affair with this ecological memory concept, and AI introduced to me by my advisor and mentors. It just seemed natural to migrate into that space."

Gay brought this unique combination of algorithmic data synthesis to JPL as a NASA Postdoctoral Program Fellow in 2023. These days, he's helping develop an artificial intelligence model to study the carbon-climate feedback amplified by thawing permafrost and the release of carbon dioxide and methane into the soil and atmosphere from subsurface microbial decomposition.

"This tool provides support that these dynamics are actually happening and we're able to forecast it," Gay says. "But the real utility is the model's flexibility, where it can incorporate any variables. For example, you can look at land surface change, you can look at black carbon from wildfire disturbances, or other environmental proxies."

As for the ongoing relationship between his art and science, Gay says they are distinct modes of thinking but, like the permafrost he studies, do experience certain feedback loops.

"There's definitely some cross-talk but they're also polar opposites," Gay says. "I think there's some beauty in incorporating both modes of thought into my work because at the end of the day, I know myself, and if I don't have some sort of magic incorporated into my thought process, it just becomes work again."

And if being a scientist becomes work again, will he go back to art?

He smiles. "That's the retirement plan."

A JPL Intern Prototyped the First-ever Crutches for Clean Rooms

By Christian Hill

College senior Preston Brumley started his 2023 summer the same way he had approached each of his previous ones at University of Colorado, Boulder: applying for internships at JPL.

“I apply every year, and this year, I got a response,” said the mechanical engineering major.

When he received the offer letter through Division 35, Brumley learned his internship was part of a pilot program set up by JPL’s Office of Inclusion to improve accessibility, and their priority for him was the task of “pioneering clean room accessibility.”

The challenge: How could JPL make its cleanrooms more accessible for engineers with long-term physical disabilities — or for those who may have sprained an ankle over the weekend — so work could still be done in controlled environments?

“I’d done internships elsewhere in cleanrooms working on flight hardware and semiconductors, so I was very familiar with a lot of the protocols involved, and excited for the opportunity to create an impact for people through engineering,” Brumley said.

With guidance from his mentors — Mechatronics Engineer (352C) and Office of Inclusion accessibility lead Eleni Comstock, and Systems Engineer Shaunessy Grant (355C) — Brumley got straight to work.

“Preston met with JPL cleanroom experts, contamination control, materials engineering, planetary protection, and mechanical engineering folks to make sure he understood all of the requirements,” Grant said. “From there, it was really up to him to come up with a design, lead the reviews, and figure out how to turn the crutches into a reality.”

Components of the clean room crutch include ChemStat-939, the same material used in the soles of clean room booties.

His first point of contact was facilities and cleanrooms expert Taguhi Arakelian (3561), who helped him sort out which materials the crutches could be made from that would limit electrostatic discharge and avoid particulate accumulation.

“The two main sticking points in the design were first to make sure the material choices were all electrically conductive, and also to make sure the crutches’ design avoided friction and slippage points, which can lead to issues with the engineer’s PPE,” Brumley said.

If the material is too slippery, it can be hard for an engineer with gloves to hold the crutches safely. But if there’s too much friction, or the design elements include sharp edges, it can tear gloves and bunny suits, risking cleanroom contamination.

One of the main design differences between Brumley’s cleanroom crutches and the set at your local drug store is the height adjustment mechanism. The standard pushpin design with holes for varying heights is not conducive for gloves — as they could get pinched when engaged — and the open holes allow for dust and particle accumulation. Brumley inverted the design, putting the holes for height adjustment on the inside tube of the crutches, and used a fastener to seal the hole from the outside.

Materials used included ESD POM Acetal — a type of hard plastic — for the underarm and handle portions of the crutches, anodized aluminum for the structure, and stainless-steel connectors and fasteners to increase stability and structure. Where there is typically a rubber tip at the end of the crutch, Brumley went with ChemStat-939, an elastomeric material found in the soles of cleanroom bootie covers.

“One of the only gripping materials allowed in cleanrooms,” Brumley said.

Most of the crutch components were assembled at JPL by Machinists Pete Bruneau and Bob Kovac, with some elements coming from Protolabs — a rapid manufacturing center often used by Division 35 for prototyping.

Brumley stands with the fully assembled clean room crutch.

With the prototype completed, Brumley executed the first cleanroom-approved crutchdesign in the U.S., and Caltech has submitted a provisional patent application on the work. Patent pending or not, the crutches provide an additional layer of accessibility for engineers in the cleanrooms, thanks to Brumley.

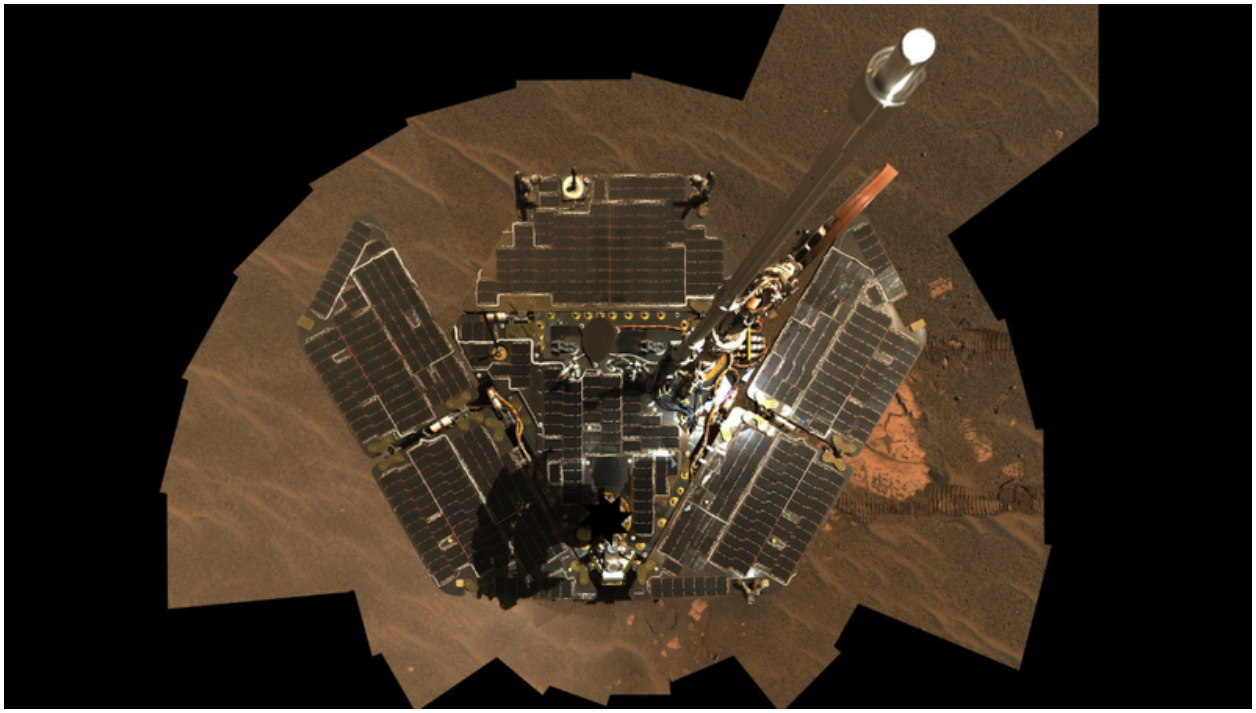
“This is really something that didn’t exist, and Preston came in here for this internship and took the lead,” Grant said. “He sought the advice and input from a lot of JPLers, but this design was his, and he really saw it through from concept to completion in the span of his internship. It’s impressive.”

As for next summer’s accessibility-focused internship, the Office of Inclusion is looking into potentially designing a wheelchair approved for cleanroom access.

With his internship wrapped up in mid-December, Brumley takes a host of engineering experience back to the University of Colorado, emerging from JPL with what he calls a “niche” in cleanroom comprehension.

“I just feel very lucky that despite not being on a technical team or space flight project, I was able to find a way to be impactful, and hopefully this is something that allows more engineers to get their work done in a safer way,” Brumley said.

JPL Events



Von Karman Lecture Series — Spirit Knocked, Opportunity Rocked: 20 Years of Rovers on Mars

Jan. 25 at 5 p.m.
Watch live on YouTube

Celebrate the 20th Anniversary of the landing of Spirit and Opportunity, the Mars Exploration Rovers. We will delve into the stories of these incredible robots, with a look at how the exploration of Mars and the understanding of ourselves has changed because of the twin rovers.

Speakers: John Callas, Former MER Project Manager, NASA/JPL; Abigail Fraeman, Former MER Deputy Project Scientist, NASA/JPL

Host: Nikki Wyrick, Office of Communications and Education, NASA/JPL

Co-Host: Sarah Marcotte, Mars Public Engagement, NASA/JPL

JPL Family News

Retirees

The following JPL employees recently announced their retirements:

50+ Years:
Patti Jansma, Section 312B, 51 years

40+ Years:
Seth L. Chazanoff, Section 357F, 45 years

30+ Years:
Jayarao Balaram, Section 3471, 39 years

Martha Pruden-Hamiter, Section 252A, 37 years

Andrew Kissil, Section 355K, 35 years

Robert J. Menke, Section 5150, 33 years

Paula R. Brown, Section 3370, 33 years

Lawrence Teitelbaum, Section 3300, 31 years

Scott G. Lever, Section 397B, 31 years

20+ Years:
Krikor G. Megerian, Section 389I, 29 years

Joe Aguirre, Section 2313, 23 years

Alex W. Campbell, Section 2400, 23 years

Jorge Sobero, Section 252K, 21 years

Passings

Dr. Harry K. Detweiler died on Nov. 16, 2023, at the age of 87. Detweiler worked at JPL for 34 years in the executive council and as director of the Office of Safety and Mission Success. He earned his MS and Ph.D. from the University of Michigan. As an electrical engineer, he was hired as a member of technical staff in 1968.

Detweiler held several positions in Division 330, participated in several flight projects and instruments, as well as worked integrally with the NASA Deep Space Network over the years. From 1996-1998, he was a manager in telecommunications science and engineering. From 1998 to 2002, Detweiler was director for engineering and mission assurance/office of safety and mission success.

He was affiliated with the Mariner, Voyager I and II, Galileo, and Pathfinder projects. Additionally, he was named on the Wall of Honor at the Smithsonian National Air and Space Museum. Detweiler's deep space radio design (Voyager 1) holds the world record for longest distance communications in space—a distance of 162 AU (24 billion km, 15 billion mi) from Earth as of 2023.

Dr. Harry K. Detweiler is survived by his wife Patricia, his children Jane, Neil, Jim, and Lisa (with their respective spouses), and grandchildren Ian, Ryan, Lance, Shelby, Cheyenne, and Sara. His funeral service will be private, immediate family only. In lieu of flowers, the family suggests tribute donations to Descanso Gardens in his name.

Passings must be submitted through Human Resources, which coordinates with the family of the deceased.