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Coronavirus and Current JPL Guidance: https://www.jpl.nasa.gov/stateofthelab

Featured Stories

Doug Hofmann (L.) and Kalind Carpenter (R.) are part of JPL's eight-person team creating 3D respirator designs now available on Open Source. Image Credit: Doug Hofmann and Kalind Carpenter

Reimagining Respirators

By Celeste Hoang

Doug Hofmann had a bad feeling in early March.

As doctors and nurses around the world scrambled for protective gear while their hospitals filled with infected and infectious patients, he knew he couldn't sit idly by. A technologist at JPL and founder of the Lab's Metallurgy Facility, Hofmann found himself in a unique position: at a time when people were still confused respirators and ventilators, he often wore respirators on the job, he was trained in the safe handling of the specialized masks, and he worked with machines that could make more.

When JPL moved to mandatory telework, Hofmann reached out to Robotics Mechanical Engineer Don Ruffatto with an idea: What if the Lab could 3D-print respirators for healthcare workers by reverse-engineering the fit and function of his own respirator mask?

“That second week of March, we were watching people die in Italy, and we knew it was coming here,” Hofmann recalls. “We were thinking, ‘If this happens here, there’s no way JPL is sitting this one out. We’re going to do everything possible.’”

As with JPL’s ventilator project, eager JPLers came running. Enterprise Software Systems Project Manager Tom Soderstrom called Hofmann a day later to say he had seen designs for 3D-printed respirators.

“I told him Don and I just started working on it yesterday,” Hofmann says. “Then he said he wanted to use Innovation funds to pursue this effort.”

With JPL’s formal backing, Hofmann, Soderstrom, and Ruffatto gathered a lean crew consisting of project managers Soderstrom, Randi Levin and Chris Mattman; technologists Hoffman, Ruffatto, Kalind Carpenter and Eric Contrearas; and JPL’s resident expert in training respirator users, Yazmin Melo.

Together, they designed and tested three different 3D-printed respirator models — invitingly named Performance, Conforming and Comfort — in less than a month, including test results, instruction videos, manuals, and specs available through Open Source.

“It was the right group of people with the right skillset at the exact right time,” says Hofmann.

3D-printed respirators designed by the team at JPL.

Making the Grade

Printing a mask was one thing. Proving it worked was another. Fortunately, the engineers behind the design were already intimately familiar with respirators since their roles on Lab required them to work with potentially harmful chemicals, stimulants and powders.

“That was a huge ace-in-the-hole that we had,” says Hofmann. “All of us go in annually for respirator fit checks so we knew there was equipment to test the quality of the fit and we even enlisted our own trainer [Melo] to support the project. We have N95 masks, we have 3M commercial respirators, and we have those two things that we compare everything else up to. We’re doing experiment-driven testing and using best-practices data.”

The team had access to JPL's TSI Portacount, a piece of testing equipment that measures the fit of the respirator by counting the number of particles inside and outside the mask and generates a fit score for how well the respirator is sealing.

JPL's 3D-printed respirator designs also have two distinct advantages over cloth masks or disposable N95s: If successful, the designs could be custom fitted for better protection and better comfort for long-term wear. The respirators' filter material folds accordion-style, reducing breathing resistance.

"You can do things with additive manufacturing that you can't do in traditional manufacturing," says Robotics Mechanical Engineer Kalind Carpenter, citing the ability to print geometries that wouldn't be possible with molds. In one design, the team was able to print shelled shapes with top portions that curve back on themselves to form an edge-free, face-sealing shape.

"This also spreads the compression over more of your face, alleviating pain and bruising," Carpenter adds. "You can make these geometries fit a range of faces, reducing the number of designs you need to certify. As few as two sizes can span a large face down to children."

One challenge to wearing respirators is the prolonged discomfort. A trip to the grocery store is long enough for most people, let alone the double-digit hours required of essential workers.

That's where the Comfort model excels.

"It's like putting your face into a marshmallow," Carpenter says. "Conforming, sealed and really comfortable was my goal."

Carpenter, Ruffatto, and Contreras have been 3D printing masks since mid-March and can print about one mask per hour; so far, they have each printed over 100. The three have also been testing various filter materials not used in the medical supply chain, including vacuum bags, which filter similarly or better than an N95.

Their goal of the respirator project is to create designs that pass NIOSH (National Institute of Occupational Safety and Health) certification, which assures that the respirator designs effectively filter particulates and can be used in hospitals. (Cloth masks do not require this same certification because they only provide protection against large respiratory droplets and don't effectively filter.)

The team has since delivered a dozen or so respirators with filters to several locations for feedback, including the governor's office, a dentist's office, a grocery store and an area hospital where doctors have been cleared to use non-medically certified personal protective equipment. Local doctors at the frontlines of the pandemic helped to fit and iterate the designs.

The respirators are also reusable and "clean off nicely" with just dish soap and water, Hofmann adds.

Help Wanted

Currently, the team is looking to get the respirator designs into the hands of a commercial manufacturer who can mass produce them for the state under NIOSH Certification.

"We want to make sure that California has the ability to produce these masks in our own state and the Governor can use his power to protect the supply chain and limit our reliance on PPE from outside of the state," says Hofmann.

Once certification and production are assured, the group hopes to supply the respirators to JPLers who need to work on Lab.

Any JPLers or members of the public with access to 3D printers can comment on and improve the Open Source designs.

“We’re just ironing out the issues along with the community to make sure it’s flexible and can work,” says Carpenter. “The more people who can figure it out and post what works, the better.”

The team isn’t just looking for scientific improvements, either—artistic improvements are more than welcome.

“One thing we’re interested in now is people’s ability to stylize and make the respirators their own,” Carpenter says. “The cover slides on and off so you can have your children decorate it or put stickers on it. If making these fashionable means more people wear them, then they are better at protecting more people.”

Kalind Carpenter's daughter, Cyra Carpenter, wearing one of his 3D-printed respirators. Image Credit: Kalind Carpenter

Carpenter, Hofmann and the rest of the team have ambitious mask iterations in mind for the future, too. They're writing proposals for such respirator features as built-in microphones and speakers (which they’ve already prototyped); Bluetooth capability; and pressure sensors that can alert the user of leaks, how long they’ve been wearing their respirator and when their filter cartridge is saturated. The team is also eyeing respirators for wildland firefighters that have built-in smoke sensors and temperature monitors.

“These are things we never considered before [with traditional respirators],” says Hofmann. “Typically, respirators are worn by people dealing with chemicals and powders that are dangerous to their health. Now, in this COVID environment, people just have to interact with other people in everyday ways. It’s about taking the standard project and ‘JPLing’ it and adding our unique fingerprint on it.”

Whatever the future holds for JPL’s 3D respirator efforts, the team knows they did what they could during a global health crisis.

“In the beginning, this was crashing over us. All of our well-laid plans were falling apart, and everything was changing every day,” says Carpenter. “This was the one thing that felt like we had a little bit of control

of that would help. Every time we couldn't sleep or the news was too much, we could go and just push forward on these designs and really work to make sure that it was going to be of value."

How valuable it is in the long run, of course, is now in arguably more important hands: the public's. Join the effort.

Victor Abrahamsson and his beer research conducted in a University of Copenhagen basement.

Stale Beer Research Leads to Fresh Studies About Organic Molecules

By Jane Platt

The career paths of JPLers are varied and invariably interesting. Such is the case with Victor Abrahamsson, a JPL postdoc researching detection of past or current life, and capability for sustaining life. It's not much of a stretch to say it all started with stale beer.

Abrahamsson's JPL work, which started in 2017, involves developing chemistry and an instrument to measure organic molecules, and may have potential applications for landers to explore other worlds.

As for the beer connection–it began in high school in Sweden, when he "didn't really have a clue what I wanted to do with my life."

Abrahamsson thought food science sounded like fun, but for practical reasons, he opted to study chemistry, with lots of food science classes. He considered chemistry a "necessary evil" but soon discovered he actually liked analytical chemistry, which he describes as "a really sweet mixture of instrumental aspects, number crunching in the form of statistics or signal processing, some organic chemistry and physical chemistry; and a lot of cool applications."

He contacted the University of Copenhagen, which had a strong collaboration with Carlsberg and Royal Unibrew and a reputation for its food science department and analytical chemistry research. Abrahamsson found a research group looking to study beer oxidation. They needed his ability to track molecules and specific proteins.

His research was published by the Journal of the American Society of Brewing Chemists in 2012, and explored the role of sulfite and thiol-containing proteins in beer oxidation – in short, how beer goes stale. Little did he know that these studies, accompanied by research about supercritical fluids during the remainder of his higher-education training, would lead him to the hunt for life beyond our planet via a postdoc opportunity at JPL. Abrahamsson has just finished his stint as a postdoc and now continues his science research at JPL.

Bonus fact: a supercritical fluid is created when a gas is pressurized and transitions to a state somewhere between a liquid and a gas. One example of its use (not studied by JPL or Abrahamsson) is that decaffeinated coffee is made by applying a heated supercritical fluid – in this case, carbon dioxide – to coffee beans, which removes the caffeine.

Although the link between beer research and the search for life beyond Earth might sound far-fetched, Abrahamsson says the principles and techniques are very similar. For example, most current and future in-situ space applications used to detect organic biomarkers utilize chromatography, which chemically separates organic molecules and analyzes very complicated samples with lots of different molecules, and fluorescent probes to detect low concentrations of organic molecules.

JPL's Employee Resource Groups include the Asian American Council, Amigos Unidos, Advisory Council for Women, the Black Excellence Strategic Team, Spectrum, and others.

Moving Forward, Taking Action

Michelle Roth, deputy director for Human Resources and the facilitator for both the Inclusion Advisory Committee (IAC) and the Employees Resource Groups Council, talked with JPL Space to discuss the actions and efforts JPL is undertaking to confront issues of social justice, inclusion and diversity around Lab.

Below, Roth explains how different groups across Lab have banded together to push for action, and created a list of action areas for the Lab to focus on.

In the past two weeks, what efforts have been made across the Lab in terms of actions and discussions regarding race, or concerns around diversity and inclusion issues?

After George Floyd's murder, HR and the leaders of the B.E.S.T. (Black Excellence Strategic Team) ERG met to discuss what actions the Lab could take to support racial justice and to be a role model in the scientific and technical community in this area. The IAC and ERG Councils also met to decide what actions the Lab should take and after reviewing all the ideas, across the groups, they were prioritized into a list of actions that would be most impactful on Lab. The list includes near-term and long-term actions.

A number of organizations across Lab including Women in Tech, Women in Planetary Science and the New Researchers Support Group (NRSG) also held allies' meetings and are partnering to support action on Lab.

Are those action areas available for JPLers to review?

We're working on how we will communicate those actions and how and when they can be implemented. We know a lot of employees want to hear what the Lab's doing. We want to make sure any communications we put out is as true as possible to how things are going to land. The main themes covered include:

- Training, education and awareness
- Time for reflection and open discussions
- Curated resources
- A stronger focus on equity, inclusion, and diversity roles on Lab
- Increased data transparency
- Continued leadership messaging and support
- Continued relationship development with HBCUs (Historically Black Colleges and Universities) and MSIs (Minority Serving Institutions)

These themes were presented to the Executive Council June 11, and they were supportive of the action items. We are now holding meetings with the ERG Council, IAC, and Allies, to go through the action items and see who is going to lead them, and drive them forward.

How did the Lab determine who to meet with and who to reach out to for discussions and potential actions around social justice, diversity and inclusion?

Determining consistent and open lines of communication between the Employee Resource Groups and the Lab's leadership is something we've been working on the past few years. In 2017, HR met with the Executive Council and recommended an increased focus on diversity and inclusion. The EC was very supportive and created an EC working group for diversity and inclusion strategy. The new Inclusion value that was implemented in early 2018 came out of this EC working group.

One of the action items that came out of that strategy was to engage more frequently with groups across the Lab to support diversity and inclusion. In October 2018, we started the Inclusion Advisory Committee, made up of six Executive Council members (Michael Greene, Mark Simons, Randi Levin, Suzanne Dodd, Robert Braun, and Michelle Roth) and put out an open call for applicants to fill six employee spots.

After we established the IAC, the next focus was to engage more with the Employee Resource Groups. In early 2019, we created the ERG council, made up of members across the ERGs, with Human Resources acting as facilitator and coordinator. Each ERG council member was assigned an HR representative to aid their group with anything they needed, including coordination tasks, how to secure funding for particular events or programs, and so on.

It was only because of the work and organization efforts over the past few years that we were able to get the action requests in to the Executive Council within two weeks. It was a coordinated effort that was carried by the ERGs and IAC, stepping up, being leaders and outlining what the Lab should do moving forward.

The first external statement from the Lab regarding recent social events came through the #pridemonth posts on the JPL Career social media pages. Can you explain how those posts came about?

Spectrum—the Lesbian, Gay, Bisexual, Transgender, Queer, Intersex, Asexual/Aromantic, and Friends (LGBTQIA+) Network of JPL—didn't want to move forward with celebrating Pride Month without having acknowledgement and engagement with current events. So, the first Pride Month posting was an ERG statement to support our Black colleagues and the Black community. We wanted to make sure that we acknowledge both Pride Month and what's going on in the world.

JPL Next Teams Give Glimpse of Projects

By Taylor Hill

As the concept phase of the JPL Next investment program is nearing an end in August, the three remaining teams—PRIME, Aerocapture, and EELS—described their systems and potential capabilities in a Lab-wide virtual presentation via Webex June 10.

“It was very impressive watching the three teams organize a lot of complex material into 30 minutes,” Thomas Cwik, manager of the Office of Space Technology, said. “One important feature of JPL Next is communicating the excitement and value of the tasks and the teams hit a home run.”

The projects include:

- **Probe using Radioisotopes for Icy Moons Exploration (PRIME):** a new robotic capability currently under development, enabling the rapid penetration and scientific sampling of tens-of-kilometers thick planetary ice shells down to the ice-ocean interface, where it would deliver ocean-exploring science payloads. PRIME will enable descent beneath the ice of ocean worlds such as Europa to characterize their subsurface, their habitability, and search for evidence of life.

- **Small Satellite Aerocapture to Enable a New Paradigm of Planetary Missions:** The SmallSat Aerocapture team is maturing a system to perform aerocapture with SmallSats, with the goal to revolutionize the capabilities of small satellites in planetary science, while acting as a pathfinder for aerocapture technology in future large missions. Aerocapture is well suited for SmallSat orbit insertion, due to the difficulty of designing and integrating a propulsion system to perform kilometers per second of delta-V on a small platform. Aerocapture presents a fast and efficient way for small platforms to enter orbit around planetary bodies and accomplish meaningful science objectives, allowing for new discoveries at a potentially reduced cost.

- **Exobiology Extant Life Surveyor (EELS):** The EELS system is a mobile instrument platform conceived to explore internal terrain structures, assess habitability and ultimately search for evidence of life. It is designed to be adaptable to traverse ocean-world-inspired terrain, fluidized media, enclosed labyrinthian environments and liquids.

Following the presentations, Cwik noted the overall goals of the JPL Next program.

“We have these big strategic tasks we’re putting together, that when one of them or more become successful down the road, they’re going to make a big difference. And that’s what we’re after.” Cwik said.

The teams will work to complete concept development by August when a selection review will be held to move a team into the project phase.

To learn more about JPL Next, visit https://spacetech.jpl.nasa.gov/next/.

Events

Von Karman Lecture Series: A Day in the Life of the Deep Space Network

Thursday, July 9 at 7 p.m.

Webcast:
Click here to watch the event live on YouTube
Click here to watch the event live on Ustream

Follow a day in the life of the Deep Space Network, from the coder to the scientist to the ACE to the spacecraft and back again. We'll explore the different aspects of what actually goes into the difficult Tetris game that is Deep Space Communications and what's coming next. This webcast show will be conducted via video conference, with speakers joining remotely from home. Watch live via YouTube and Facebook and submit your questions via the chat.

Speaker:
Joseph Lazio — Chief Scientist, Interplanetary Network Directorate

Hosts:
Brian White
Heather Doyle

JPL Family News

Retirees

The following JPL employees recently announced their retirements:

30+ Years:

Jonathan Cameron, Section 347D, 35 years

20+ Years:

Chris N. Cornwell, Section 1750, 25 years

Janice Ball, Section 3314, 21 years

Susan J. King, Section 1733, 21 years