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Featured Stories

Image Credit: PhotoLab

5 Things to Know About the Open Source Rover Program

High school students, open-source maker clubs, and garage tinkerers worldwide have built legions of powerful and customizable mini rovers, thanks to a JPL-founded open-source project.

By Vincent Robbins

In March of 2023, a little six-wheeled rover named Raf sat idly by as its builder gave a talk about the Open Source Rover community at a conference in Pasadena. As Raf sat staring blankly at the audience, the sacred homeland of its robot species sat mere miles away.

It was Raf's lucky day. After the talk, a fan approached, eager to admire Raf's craftsmanship and engineering prowess. That fan was Lan Dang, an engineering applications software engineer and the JPL liaison for the Open Source Rover project.

Dang offered to take Raf and its builder on a visit of this mythical, ancestral site known as the Jet Propulsion Laboratory. Raf's homecoming tour took place a few days later.

Open Source Rover is a build-it-yourself robotics project in the form of a scaled-down version of the rovers that explore the surface of Mars. Made entirely from consumer off-the-shelf parts, OSR is an engaging and affordable learning experience for budding enthusiasts in mechanical engineering, software development, electronics, and robotics. No prior skills or knowledge are required. The project is also — you guessed it — open source, a term that refers to computer software that is released to the general public to use, study, and change for collaboration and experimentation.

Below, we spoke to Dang about the five most interesting things about the project, its history, and life out in the world for the fleet of robots that have come online since plans for the rover were released in 2017.

1. The Open Source Rover was designed by two JPL interns.

In the summer of 2017, then-JPLer Mik Cox and interns Olivia Lofaro and Eric Junkins prototyped an open-source, affordable version of Rov-E, a rover that the Public Engagement office uses for events. The goal was to bring the cost down from $30,000 to a price tag more accessible for hobbyists or high school students. Interns Lofaro and Junkins did much of the legwork, in consultation from robotics engineers on Lab. Cox managed the project and found a champion in Tom Soderstrom, then the Lab's chief technology and innovation officer.

The outcome: a little rover that cost about $2,500 to make but functions much like its role models Curiosity and Perseverance — employing driving mechanics such as the rocker-bogie suspension, differential pivot, and 6-wheel Ackerman steering that allow it to traverse rocky surfaces here on Earth. The control system operates on a Raspberry Pi — a cheap, versatile microcomputer that connects via Bluetooth, WiFi, and USB — allowing for versatility and simplicity in customizing the rover's "brain." It was also designed with the potential to add expansions like a head display or robot arm.

Mik Cox (left) shows off the original Open Source Rover at the DTLA Mini Maker Faire in 2018.

Although Dang doesn't have a background in robotics or mission formulation — her role on Lab is focused on large-scale data processing — she has been involved in the open-source community for years and is a member of the SGVHAK open-source maker group. She met with Cox and Junkins in 2017 to discuss documentation distribution and community building and also volunteered her maker group to participate as one of the initial beta testing groups. In early 2018, Dang's group built their SGVHAK Rover and began to engage with the OSR community and exhibit the rover at local events.

Following the winding down of JPL's direct involvement in 2021, Dang stepped forward as the JPL liaison to the OSR community. Dang now administers the OSR GitHub repositories — a tool used by programmers to maintain and control sets of files that are used collaboratively during software development. She has also found opportunities to show off OSR, including the Caltech Science for March, the Southern California Linux Expo, and the DTLA Mini Maker Faire.

2. The project was designed to take on a life of its own outside of JPL.

Initial champions Soderstrom and Cox had a vision for the project to be open source. They hoped the low barrier to entry would catalyze a community — both at JPL and around the world — to contribute ideas, metrics, and stories to the project.

"[Soderstrom] really had this vision that he wanted this to be an outreach rover in the sense that it gave high schools and colleges a way to do robotics the way that we do at JPL," Dang said.

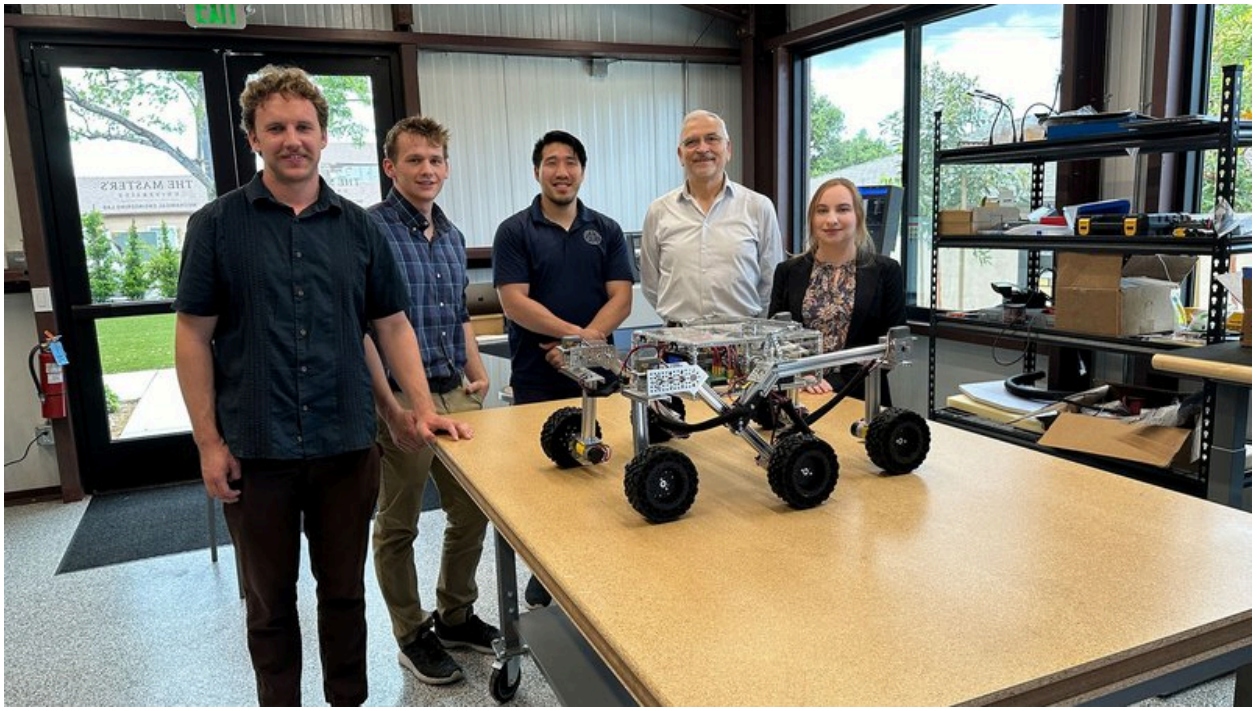
Nearly seven years later, even without direct JPL involvement since 2021, OSR is one of the largest and longest-running open-source complex hardware projects, with a global maker community.

The GitHub repository has been consistently active for the past six years and is one of the most-starred open-source hardware projects of all time. The project has been "forked" — essentially duplicated to iterate on ideas or changes before they are proposed back to the upstream repository — on GitHub over 1,000 times and starred 8,000 times.

3. There are (at least) over 50 groups all across the globe that have built OSRs.

The list of groups that JPL knows about — and there may be plenty more — includes rovers built in the USA, Mexico, UK, Ireland, Germany, Sweden, Finland, Turkey, India, Japan, Australia, Netherlands, Slovenia, Poland, New Zealand, and Brazil. Several high school groups successfully built the rover, including Santa Susana HS in Simi Valley who is on their fourth rover. OSR has been built as a robotics platform at several universities, including Cal Poly Pomona San Luis Obispo, University of Hawai'i at Mānoa, and Georgia Tech University. The OSR maintains a builder's gallery with hopes of cataloging rovers, but Dang said not every group that has built a rover participates in the community.

Most recently, Dang and Principal Flight Software Engineer Tim Canham attended a capstone project presentation of OSR at the Master's University in Santa Clarita. The team of students relied heavily on the OSR community in the run-up to their final presentation.



L to R: Master's University students Blake Power, Kevan Ross, Engineering Department Chair Joey Kim, Faculty Advisor/Professor Dan Dubei, and student Rachel Whidden, pose with their Open Source Rover. Photo credit: Timothy Canham.

"They got a lot of help with the troubleshooting and uncovered some known and unknown issues with the build documentation," Dang said. "They managed to finish the rover and get it working the night before their presentation."

4. A new version of the rover came out last year.

Open Source Rover 2.0 — which was designed entirely by the open-source community — addresses many pain points builders have encountered in the original concept, such as the electronics not being weatherproof, difficulty finding parts, and complexity with some of the build instructions. It also takes advantage of how technology has changed and how easy it is to outsource laser-cutting and 3D printing. One more bonus: the new model cuts the cost down to about $1,500.

Many groups are already working on building OSR 2.0, including Santa Susana High School in Simi Valley, who recently featured their rover at the Southern California Linux Expo, and Dang's own maker group. The student project group at Master's University also worked on this updated version, and Girls in STEM at the Columbia Memorial Space Center is planning on building a pair of Open Source Rovers in the fall.

5. OSR has been used by other JPL projects.

JPL recently teamed up with Goddard Space Flight Center for a Defense Advanced Research Projects Agency effort to test rapid-patching capabilities for mission-critical legacy flight software systems. To do this, they needed to create a model testbed to simulate communication between ground, satellite, and spacecraft systems. For the spacecraft component, Lini Mestar and intern Victor Jimenez constructed a rover based on OSR plans — a system in which they could introduce bugs for the team to identify and patch.

"The rover provided the [DARPA] program with a challenging edge-case test bed to push the boundaries of their research and drive the program objectives forward," said Amanda Towler, JPL's P.I. for the program.

The rover traveled all over the U.S. to various program events, with Jimenez working tirelessly with a 3D printer and soldering iron to keep the hard-working rover functional. After its final program event this May, Towler says the next phase of their research involves using the OSR platform to explore Large Language Models as a new command and control interface.

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Although the OSR community has thrived without JPL's direct involvement, Dang hopes the Lab will support the project again in the future. She said she sees an opportunity to support school groups and universities that are using the project as a learning experience, partner with other JPL open-source projects, and collect the stories of innovative groups using the platform for experimentation.

As for the original OSR team? They have moved on from JPL, but Junkins, one of the two interns who designed the rover, is still involved with the OSR community. Not just involved, but engaged: he and his fiancée met when Junkins was working on the project, so they built a rover to serve as ring bearer at their wedding.

Samwise, the rover built by Junkins and his fiancée, delivers the rings at their wedding.

Strategy, Art, and Culture Fit Together on the Mall

Besides food, fun, and fashion, the recent JPL Cultural Festival introduced a community art project based on the Lab's Strategic Imperatives.

By Christian Hill

As JPLers celebrated their varied backgrounds and favorite foods at the June 13 Cultural Festival, a vertical puzzle took shape nearby.

Assembly started small, with a handful of interlocked panels of painted plywood three feet across. By festival's end, the puzzle tower counted more than 40 colorful panels inscribed with words, phrases, and drawings representing JPLers' takes on the Strategic Imperatives in "A Plan for JPL."

Visual themes drew the first glance: intricately drawn Curiosity and Perseverance rovers, a stunning pointillism-inspired galaxy, satellites orbiting our planet.

But it was the words accompanying many of the drawings that captured JPLers' thoughts on how the Lab will face a changing space sector, advance exploration, and continue to inspire future generations — words such as "trust, empathy, and teamwork" next to a drawing of a multi-colored brain representing the thought processes of a great manager; and "bring the samples home!" scrawled in pink cursive.

It wasn't just the work of a couple of hours. Prior to the festival, JPLers were invited to art-making sessions over the course of three lunches at JPL's cafés to write and doodle on the panels, responding to broadly worded prompts such as:

- What does JPL do best?

- When do you feel most connected to people?
- What big scientific question do you hope we solve in your lifetime?
- What will JPL be known for in 100 years?

The day of the festival, the panels created during the lunch sessions were collected and brought down to the Mall, where more JPLers had the opportunity to contribute.

As installation organizer and Cultural Strategist David Delgado watched the project come together on June 13, one image caught his eye. It was a teddy bear atop a rover as a response to the prompt: “If JPL were a superhero/superheroine, what would be its superpower, what would be its kryptonite?”

“The person who drew that explained that sometimes JPLers care too much about their projects and that this quality can become our kryptonite,” said Delgado. “It immediately rang true to me based on my experience here. It’s important that we care. And we want it to be a superpower, not our kryptonite. It would be interesting to know if other people thought this was a characteristic of our culture.”

Delgado conceived the installation with Thom Gottelier, an affiliate with DesignLab, and Kareem Collie, DesignLab manager.

“The Strategic Imperatives are something that the SI teams and the Lab as a whole have been thinking about and in many cases working on over the past year, but these prompts provided an opportunity to focus less on the exact details or specific ideas, and really make it more personal,” Delgado said. “It opened the door a little bit wider to think differently about JPL.”

While the art installation was disassembled following the conclusion of the Cultural Festival, the panels are likely to resurface: the DesignLab team plans to place smaller configurations of the art piece in building lobbies around JPL.

Events

Von Karman Lecture Series: How NASA's Team of Autonomous Mini Rovers Will Explore the Moon

Thursday, July 18 from 5 to 6 p.m.
Watch on YouTube

What's happening: A team of rovers will soon be working together to explore the Moon – autonomously! NASA's CADRE (Cooperative Autonomous Distributed Robotic Exploration) technology demonstration is sending three small rovers — each about the size of a carry-on suitcase — as an experiment to map and explore the lunar surface. The tech demo marks NASA's first fully autonomous space mission involving multiple rovers working together.

Why this matters: The solar-powered rovers will test novel, JPL-developed autonomy software, using it to elect a "leader," make decisions, and carry out tasks assigned by the leader — all without the need for constant direction from human mission controllers. They will use mesh network radios to communicate with each other and their base station, which will remain aboard a commercial lunar lander that will relay data to Earth.

CADRE also will show how teams of robots can collaborate to take simultaneous scientific measurements from different locations, gathering data that would be impossible for a single robot to record. The tech demo could pave the way for autonomous, multi-robot missions that change how celestial bodies are explored.

Speakers:
Subha Comandur, CADRE Project Manager,
Jean-Pierre de la Croix, CADRE Principal Investigator

Host:
Nikki Wyrick, Communications and Education Directorate

Co-host:
Sandy Marshall, Solar System Public Engagement Specialist

JPL Family News

Retirees

The following JPLers have announced their retirement:

30+ Years:

Don Nguyen, Org 335B, 38 years
Sammy Kayali, Org 1000, 36 years
Joanne Kennedy, Org 2503, 36 years
Todd Bayer, Org 3130, 35 years

20+ Years:

Katherine Younker, Org 8010, 29 years

10+ Years:

Carlos Quintanar, Org 174A, 10 years