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Curiosity stands up, begins taking shape

Mars Science Laboratory rover gets its first test drive

By Mark Whalen

As a father of two young children, Dave Gruel knows all about the excitement of those first baby steps—the realization that your little one is finally ready to begin the journey of a lifetime.

But it's his baby right here on Lab—the Mars Science Laboratory rover Curiosity, currently undergoing assembly, test and launch operations in a JPL clean room—that's making him feel like a proud dad these days.

"Look on the floor of the spacecraft assembly facility right now and you'll see a rover that, for the first time, actually looks like a rover," Gruel said. "It's got its wheels on, a high-gain antenna, and we'll get a robotic arm pretty soon."

Technicians and engineers also recently mounted Curiosity's mast, which contains two navigation cameras (navcams), two mast cameras (mastcams), and elements of the ChemCam laser chemistry instrument.

Gruel, who manages the rover's preparatory activities as it readies for launch in fall 2011, beamed as team members guided Curiosity through some key milestones July 23. Curiosity not only stood firmly on its six wheels for the first time, but also completed a series of short two-meter test drives as well.

Gruel noted that while the mechanical team has had engineering models of the rover and the mobility system driving on the ground before, "This is the first time we've had the flight rover with electronics in it, with harnessing on it, actually sitting on the ground on its own wheels. It's a great demonstration of all the hard work and effort everyone on the project has put forth to this point."

The short drive atop some aluminum matting assured that the rover's mobility system worked as expected and that any interference issues between the wheels can be addressed sooner rather than later.

"This fall, as we continue to get more confidence in the system and the software becomes more mature, we'll do some more aggressive drives by going over ramps and other obstacles," Gruel said. "Just like kids go from crawling, to their first steps while holding onto something, to then being able to run around on the floor and explore their surroundings—we're doing the same thing."

Dutch Slager / JPL Photo Lab

Technicians and engineers in the Spacecraft Assembly Facility survey Mars Science Laboratory's Curiosity rover as it goes for its first test drive July 22.

Indeed, assuring the rover can ultimately drive over the rocky Martian landscape to explore the Red Planet represents the project's bottom line, but the July 23 driving demonstration served numerous other key purposes as well.

"Every subsystem we have on this vehicle is exercised to some extent by this one test," Gruel noted. Under scrutiny were the test equipment that sends commands to the vehicle; avionics; flight software; harnessing between avionics and actuators; structural support; telecommunications; and the thermal design, so the vehicle doesn't overheat.

Curiosity underwent a system test in late July that simulated the mission's launch and cruise to Mars. "We're also running tests that will simulate the vehicle going through the Martian atmosphere and make sure all the sensors and algorithms are responding properly so that it will get to the surface as intended," Gruel said.

Curiosity's robotic arm is due for delivery and tests in early August, and Gruel said care must be taken to avoid contamination.

"We won't test it by taking samples," he said. "We want to keep the arm really pristine so when it gets to Mars the instruments are actually analyzing Mars and not contamination from Earth. We will extend the arm so it's close to touching things, reaching different ori-

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Help from space pioneer spurs interns shooting for the moon

By Mark Whalen

A group of summer students at JPL that is considering payloads that could be included onboard a proposed moon mission recently received some help from a NASA pioneer and legend.

Since mid-June the group of 15 has been brainstorming ideas for a student collaboration project that would be considered for flight aboard MoonRise, currently in competition under NASA's New Frontiers Program. If selected for development, MoonRise would be NASA's first mission to robotically return samples from another planetary body.

The group has been learning about all aspects of JPL missions, from science objectives and spacecraft design to payloads and launch vehicles. When it came to public engagement, they went for advice to Sally Ride, NASA's first female astronaut and currently the education and public outreach lead for the upcoming Gravity Recovery and Interior Laboratory, or Grail, mission, which JPL manages.

Ride is leading MoonKam, an educational initiative that will use cameras on Grail's two satellites to engage middle schools across the country in lunar exploration. Students will use images sent back by Grail to study lunar features while also learning about future landing sites.

JPL's Leon Alkalai, capture lead for both MoonRise and Grail, worked closely with Ride on the formulation of the Grail education and public outreach plan and student collaboration project using MoonKams. "I called Sally and asked her if she would meet with the MoonRise students and also advise us on E/PO and student collaboration project ideas," Alkalai said. "And of course, she agreed."

"It was really cool because I started out being inspired to study science after I attended Sally's science conference in 6th grade. I really loved it," said Danielle DeLatte, a senior at MIT. "Whenever you hear about girls not going into science or engineering, it's really great to have an example of success. So I think the fact that she's using her fame to do this great outreach is fantastic."

Ryan Clegg, a graduate of Florida Tech, decided in 8th grade that she wanted a career in science, including thoughts of becoming an astronaut. "All through high school I was made fun of by my friends and everyone I knew; 'Yeah, you're never going to do that.' "But just to meet Sally Ride, who I'm sure had to go through the same kind of difficulties, it was inspirational for me to meet someone who has accomplished their goals and didn't let anybody stand in their way."

Clegg, who will attend graduate school at Washington University in St. Louis—the same school that employs MoonRise principal investigator Brad Jolliff—attended college about an hour from Kennedy Space Center and has served two internships there. "I had studied lunar soil," she said, "so when I heard about this opportunity to actually work on a mission that's going to the moon, I got really excited."

The goal of the summer program, which runs through mid-August, has been multifaceted, said JPL mentor Brian Schratz of the Communications Systems and Operations Group.

"First they debated what is valuable to the science community in general and came up with specific goals to identify," Schratz said. While considering individual factors such as cost, mass, available technology and feasibility, the group has also learned to think about the big picture. "They need to be cognizant of how as an engineer everything they do ultimately affects the science of the mission and its goals," Schratz said.

"It's important for them to go beyond their discipline," added JPL faculty mentor Kourosh Rahnamai. "Even if you end up adding one small instrument to MoonRise, in the process of designing it you have to consider all spacecraft subsystems."

That said, Schratz acknowledged, "It's easier for them to build an instrument rather than trying to build an entire spacecraft." Two possibilities have emerged.

One would go on the landing craft and would measure the radiation on the lunar surface; the second idea would place an array of cameras on the communications satellite to take imagery over the bright side of the moon similar to MoonKam. On the dark side of the moon, impacts could be monitored as well.

"When people who go through programs like this come to the real world, in an environment like JPL, they are able to hit the ground running much faster and much more able than, say, someone who's worked on a widget in a research lab," Schratz noted. "So hopefully that grooms them better, not just as JPL employees of the future, but also going back to their universities gives them the perspective of how a spacecraft is actually put together."

A decision on the New Frontiers proposal among MoonRise, the Surface and Atmosphere Geochemical Explorer mission to Venus—which JPL would also manage—and the Origins Spectral Interpretation Resource Identification Security Regolith Explorer spacecraft, is expected mid-next year.

"If the MoonRise proposal wins, we're hoping there's a good chance for us to be successful and go on," Rahnamai said.

Front row, from left: Nate Butler, Kourosh Rahnamai, Laurence Bodek, Payam Banazadeh, Sally Ride, Alessandra Babuscia, Ryan Clegg, Danielle DeLatte, Mary Knapp. Back row, from left: Ethan Sox, Kevin Chou, David Austerberry, Charles Galey, Fernando Saca, Natalie Accardo, Leon Alkalai, Mitch Muller, Daniel Alkalai, Jeremy Klein.

MSL *Continued from page 1*

entations, making sure it does what it's supposed to do and the team fully understands how it operates."

Overall, Mars Science Lab's rigorous testing covers all mission phases: launch, cruise, entry/descent/landing, surface general, surface sampling and remote science. During the current testing period that continues through October, about 200 test cases are analyzed; another several hundred are scheduled to follow in November and December.

"This is an incredibly capable vehicle, with lots of redundancy, lots of functionality, and complicated science instruments unlike anything we've put on the surface of Mars before," Gruel said. "All that complexity makes the system—the software, the fault protection, the algorithms—all the more complicated too."

Gruel noted that from here on out the team's main focus will be on the rover. The assembly of the project's cruise stage has been almost completed; the descent stage recently successfully completed a random vibration test to assure a safe launch; the backshell previously received much of its required work on the mission's original timeline; and the flight heat shield is currently at industrial partner Lockheed.

Mars Science Lab will be shipped to Kennedy Space Center next May. But time goes very fast, Gruel cautioned.

"There are certainly some challenges ahead of us, but we're coming pretty close to hitting the schedule milestones we laid out when the launch was delayed," he said, noting that rover environmental testing next spring will include checking for vibration, pyro shock, heat and cold.

"It's imperative that MSL is successful, and we're optimizing the amount of time we have with Curiosity," Gruel said. "Everyone realizes that this project has had more than its share of issues. But right now, we're all extremely confident that we will be able to complete the assembly and test of this flight vehicle on schedule and deliver it to the launch vehicle team to hit our November 2011 launch window.

"As you can tell from the sheer size of Curiosity, it took everybody doing his or her job to get us to this point," he added. "All 750-plus people on the project contributed to this day, in one way or another. It's a big accomplishment for everybody, and they should take a moment to step back and reflect on all their hard work—this is what it's all about, this is what you're working so hard for."

For more information on the mission, visit *http://mars.jpl.nasa.gov.*

Disability inspired his vision

Device built to aid note-taking wins worldwide competition

By Mark Whalen

Three years ago, Arizona State University student David Hayden decided to add a math degree to the computer science degree he was already working on. But the frenetic pace of note-taking in senior-level coursework proved frustrating. Hayden, born with a condition in which his optic nerves never fully developed, is legally blind, and has trouble keeping up with note-taking.

Hayden, working this summer in the Artificial Intelligence Group under the JPL Education Office–sponsored Minority Initiatives Internship Program, had used assistive technologies in the classroom with limited success to that point. But he couldn't wait for the state of the art to catch up to his needs, so he decided to do something about it himself.

The result, a device he built called the Note-Taker, has not only helped him in class but has earned him and his team members a major prize in the recent Microsoft-sponsored Imagine Cup, an international technology innovation competition held this year in Warsaw, Poland, that included about 300,000 student entrants from more than 100 countries.

The competition was stiff in the Hayden team's category, touch and tablet accessibility—50 teams from around the world had entered. Teams were called upon to use touch and tablet technologies to improve access to education, which proved a natural for Hayden's team.

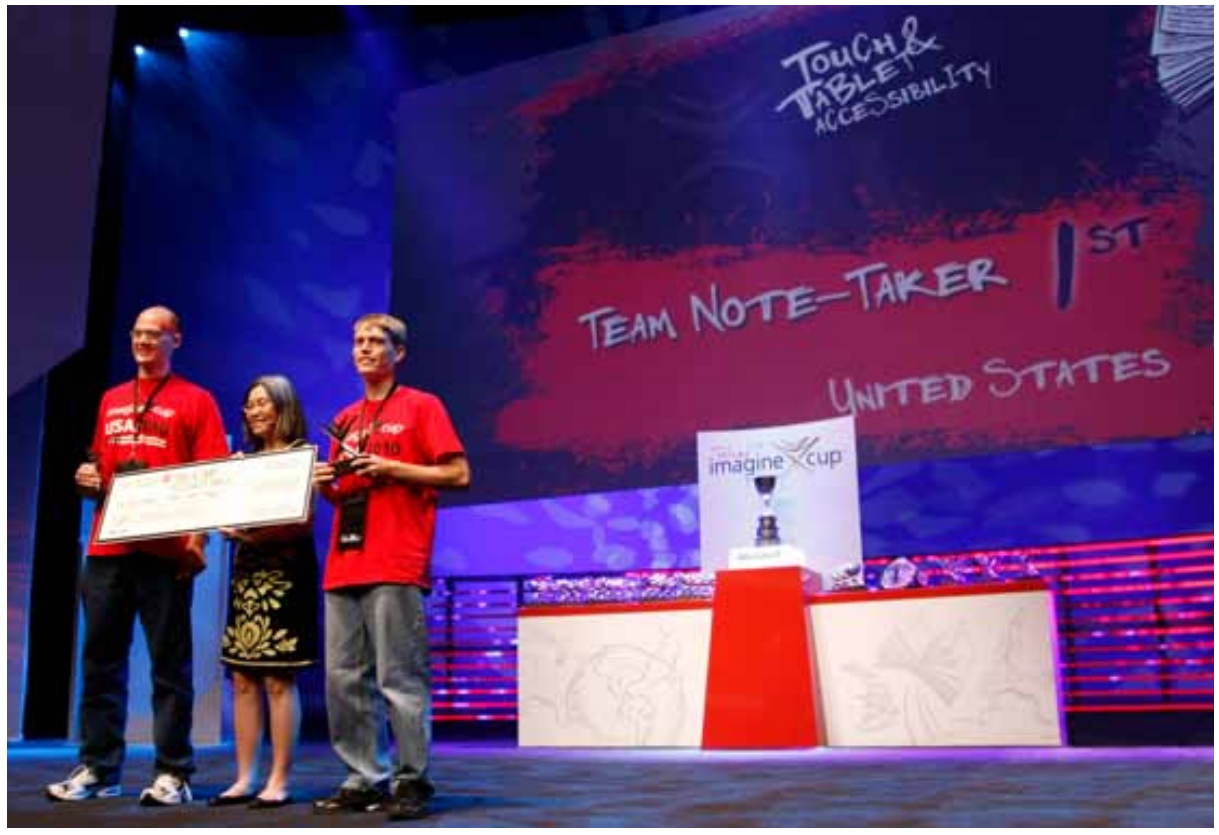
"It was as if the challenge was created just for our project," Hayden said. "The reason the tablet PC was so important to our device is that handwritten notes are critical for STEM classes; what happens when you run into figures, diagrams or math notation?"

After an initial down-select to 10 and then finally two in the Warsaw final, Hayden and Arizona State teammate Andrew Kelley took home first place. The six team members garnered a prize of $8,000 and tablet computers.

"The basic problem the Note-Taker solves is that, unlike existing assistive technologies, it's portable, requires no lecture adaptation or building infrastructure, and there's no delay when transitioning between taking your notes and viewing the board," Hayden said. "Both are on the same screen. This allows low-vision students to keep up with note-taking compared with their sighted peers."

The Note-Taker sits flat on a desk. On one half of the screen is a digital note pad, where users enter handwritten notes; on the other half is live, streaming video from a camera that points at a target such as a chalkboard. In the video window the user can "drag" the live picture and the motors on the camera will pan and tilt to readjust its position.

The device's first-generation prototype was an amalgamation of commercial, off-the-shelf technology but showed enough promise that Hayden received some seed funding from the Center for Cognitive Ubiquitous Computing, where he had been volunteering. The team is currently working in the second of a two-year grant from the National Science Foundation.



Above: JPL's David Hayden (left) and teammate Andrew Kelley (right) are awarded first place at the Microscoft Imagine Cup finals in Warsaw, Poland.

Left: David Hayden uses a prototype of the Note-Taker.

Hayden said a second-generation prototype is now being lab-tested. A third generation, which he said is much closer to a marketable product, will be completed this fall. "We're going to distribute the third-generation prototype to a dozen low-vision or legally blind students for an extended user study," he said. "Based on the results, we'll design a fourth-generation device that would be ready for manufacturing."

This is Hayden's third summer working in JPL's Artificial Intelligence Group, where he studies how to autonomously sort remotely-sensed imagery according to specific science objectives.

"In many cases, spacecraft can collect far more data than could be sent back for human observation," he said, "So, how do we run programs onboard that can preselect data according to autonomous measures of their scientific value?"

Does Hayden see this type of work in his future? "Absolutely," he said. "Machine learning is the fundamental domain I'm interested in. There's a little bit of that type of work in Note-Taker—it's using computer vision; the work I'm doing with Steve Chien and David Thompson is as much computer vision as machine learning."

Hayden, who plans on beginning a Ph.D. program in computer science in fall 2011, is interested in developing devices that will help many more than those with low vision. Ultimately, he sees his research bringing computers on or in the body to assist human perception, cognition and mobility; i.e., wearable computers or prosthetics. "I'm particularly interested in the applications of machine learning and computer vision to those types of technologies," he said.

For example, the Note-Taker allows users to text-search and select their handwritten and typed notes. Selected notes can then cue audio or video that was being recorded at the time the notes were being taken. "Once we get that into a nice user interface, and slim down the camera peripheral, the Note-Taker will become more attractive for fully-sighted students."

"It's nice if you can design technology to help a small portion of the population, but it's even better when you can generalize it so that it can help everyone. The ideal of that would be: Can normal human vision ever be enhanced beyond its current state? It's not clear that it's possible, but it's something I'm interested in considering."

News Briefs

Michael Shao

Shao honored for interferometry work

Michael Shao, manager of JPL's Interferometry Center of Excellence, has won the 2010 Michelson Prize from the International Astronomical Union and the Mount Wilson Institute.

At a recent meeting of the International Society for Optical Engineering, Shao was honored for his many years of fundamental contributions to the field of optical interferometry and for his pioneering work on ground-based and space-based interferometers, including the Keck Interferometer, for which he served as project scientist.

Shao, who joined JPL in 1989, is currently the project scientist for the Space Interferometry Mission.

The Michelson Prize is awarded to provide recognition within the interferometry community, as well as in the broader science community, of scientific research and results from the rapidly growing field of optical interferometry. Shao was honored under the prize's Lifetime Achievements category, which recognizes a substantial history of contributions and international leadership as evidenced by publications, advancement of knowledge, reputation, procurement and management of resources, or accomplishments of former students.

New Johnston book views semiconductors

Allan Johnston, principal staff engineer in the Electronic Parts Engineering Office, has authored a new book, "Reliability and Radiation Effects in Compound Semiconductors."

Allan Johnston

Written for advanced engineering students as well as professionals working in the aerospace industry, the book contrasts reliability and radiation degradation mechanisms in compound semiconductors with those of silicon-based devices, and shows that the reliability of many compound semiconductors has improved to the level where they can be used for 10 years or more in space applications. It also discusses optoelectronic devices as well as advanced transistor technologies that allow operation at very high frequency.

For more information, visit *http://worldscibooks.com/engineering/7331.html*.

JPL instrument to go on 2016 ExoMars orbiter

A JPL instrument has been chosen to fly on the first orbiter planned under a new joint program of Mars exploration by NASA and the European Space Agency beginning in the next decade.

The ExoMars Climate Sounder, led by principal investigator John (Tim) Schofield of JPL's Earth and Planetary Atmospheres Group, is one of five instruments selected for the ExoMars Trace Gas Orbiter. Scheduled to launch in 2016, the orbiter is the first of three joint robotic missions to the Red Planet, and will study the chemical makeup of the Martian atmosphere with a 1,000-fold increase in sensitivity over previous Mars orbiters. The mission will focus on trace gases, including methane, which could be potentially geochemical or biological in origin and be indicators for the existence of life on Mars. The mission also will serve as an additional communications relay for Mars surface missions beginning in 2018.

The JPL climate sounder is an infrared radiometer designed to provide daily global data on dust, water vapor and other materials to provide the context for data analysis from the spacecraft's spectrometers

The selection of the instruments begins the first phase of the new NASA–European Space Agency alliance for future ventures to Mars. The plan consists of two Mars cooperative missions in 2016 and 2018, and a later joint sample-return mission.

Besides the European-built ExoMars Trace Gas Orbiter, the 2016 mission features a European-built small lander demonstrator, a primarily U.S.–international science payload, and NASA-provided launch vehicle and communications components. European Space Agency member states will provide additional instrument support.

The 2018 mission consists of a European rover with a drilling capability, a NASA rover capable of caching selected samples for potential future return to Earth, a NASA landing system, and a NASA launch vehicle. These activities are designed to serve as the foundation of a cooperative program to increase science returns and move the agencies toward a joint Mars sample return mission in the 2020s.

JPL manages the Mars Exploration Program and the development of the NASA-supplied instruments for the 2016 orbiter.

For more information, including the entire list of instruments onboard ExoMars Trace Gas Orbiter, visit *http://www.jpl.nasa.gov/news/news.cfm?release=2010-254*.

Passings

Jay Bondi

Jay Bondi, 77, a retired engineer, died March 28.

Bondi worked at JPL from 1953 to 2002. He is survived by his wife, Carole, and sons Brett and Eric.

Retiree **Anita Hixson**, 96, died April 10. She worked at the Lab from 1960 to 1976.

Hixson is survived by daughter Joan and son Rick. Services were held at Mountain View Cemetery in Altadena.

Retiree **Hyder Ali,** 74, died May 30.

Hyder joined JPL in 1984 as manager of the Network Information Management System and the Anomaly Reporting System. He served as a member of the original JPL Institutional Software Management Standard Committee to establish software standards at JPL. Later, he worked as a system engineer in the Telecommunications and Mission Operations Directorate Program Office, retiring in 1998.

Hyder is survived by sons Arif, Zahid and Selmaan.

Milton Noel

Milton Noel, 89, a retired propulsion research engineer, died June 23.

Noel worked at the Lab from 1947 to 1984. As a test cell technician he worked on the early development of Explorer 1, America's first satellite. In the 1950s he transferred to the Propulsion Research Section, where he did experimental research and propulsion heat transfer, including evaluation of cooling capabilities of a variety of liquid propellants. He also assisted in the design, fabrication, instrumentation and evaluation of cooling requirements for rocket-type nozzles. Noel was part of the launch team for the Viking and Voyager missions.

Noel is survived by his wife, Phyllis, sons Michael and Donald, three grandchildren and two great-grandsons. A celebration of life will be held Saturday, Aug. 14 at 2 p.m. in the Hemet United Methodist Church, 530 S. Buena Vista St., Hemet, 92545.

Retiree **Donald Hanks,** 78, died July 18.

A veteran of the Korean War, Hanks joined JPL in 1957 and worked on various projects including Viking, Mariner, Voyager and Cassini. He also worked on a number of Department of Defense projects including the Corps Battle Simulation and Aquila UAV. He retired in 1997.

Hanks is survived by his wife Jill, sons Patrick, Andrew, David and Michael, and nine grandchildren. A memorial was held in Valencia.

Letters

I would like to thank all of Alex Stone's co-workers for their thoughtfullness and kind words on the passing of Alex. Thank you to the ones who were able to accompany him to his last journey.

Susan Stone

My family and I appreciate the support and sympathy received from friends and co-workers in Section 388 and the Cassini project during the recent passing of my mother in June. Thank you all for the cards, notes and the lovely orchid we received. Your kindness was greatly appreciated. Knowing that we were not alone has helped ease our grief and sadness. Sincerely,

Julia, Jim and Jamie Henricks

My husband and I would like to thank our many friends and co-workers at JPL who have shown their support during the recent passing of my father, Harry Goudsmid. The cards, e-mails, phone calls and the beautiful plant we received were all greatly appreciated. Thank you all for your thoughtfulness and friendship at this difficult time and for reminding us why we work at JPL.

Elsa and John Waters

My family and I would like to thank JPL and our friends and co-workers for their support during the recent illness and passing of my mother, Marjorie duFossé. It was a difficult time for us and your care and support helped us through it. Thank you also for the lovely plant. Anthuriums were always a favorite of hers.

Paddy and Rob Lock

My family and I would like to thank the many JPLers for their thoughts and prayers on the recent passing of my mother. Thank you all for the beautiful plant. Your sympathy has been very comforting to my entire family during this very difficult time.

Raúl Romero

Retirees

The following JPL employees retired in July:

Edgar Davis, 48 years, Section 382; **John Tallon,** 32 years, Section 352; **Albert Johnson,** 30 years, Section 5145; **Margaret Borzage,** 29 years, Section 501; **Robert K. Wilson,** 20 years, Section 701; **Pamela Conrad,** 11 years, Section 3220; **Rosemary Sullivant,** 10 years, Section 1832.

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