Jet Propulsion Laboratory

Universe

NOVEMBER 2011
VOLUME 41
NUMBER 11

Curiosity's next stop: Mars

By Mark Whalen

Mars Science Laboratory set for Nov. 25 launch

Technicians at Kennedy Space Center work beneath Mars Science Laboratory's aeroshell, which has been mated to the cruise stage. The mission's Curiosity rover is visible, tucked into the aeroshell.

Final preparations are underway for the launch of JPL's Mars Science Laboratory, scheduled to lift off from Kennedy Space Center the day after Thanksgiving, Friday, Nov. 25.

Liftoff is scheduled for 7:25 a.m. Pacific time with a window through 9:08 a.m. Pacific time that day. The launch period extends through Dec. 18. The spacecraft is due to reach Mars the evening of Aug. 5, 2012 Pacific time.

JPL will be providing Thanksgiving dinner in Florida for the assembly, test and launch operations team members on hand for the final stages of assembly of the most sophisticated and ambitious rover yet sent to the Red Planet. The car–sized Curiosity rover, with a payload more than 10 times as massive as the Mars Exploration Rovers, will assess Mars' habitability on a surface mission of almost two Earth years.

"There is a very complicated and choreographed set of procedures to do the final stacking, power the vehicle and make sure everything is safe on the launch pad," said Mission System Manager Michael Watkins. "That's the team's focus right now."

A critical prelaunch task is to ensure good communications between teams at JPL and Kennedy on launch day and a safe and smooth handoff of the spacecraft from the Florida team to JPL. Watkins said the project team at Kennedy is effectively controlling the spacecraft until it launches, at which point JPL's project team in the mission support area in Building 230 takes over.

Watkins noted that the assembly, test and launch operations team had full participation in an operations readiness test Oct. 27–28.

More than 200 engineers will be involved in getting the rover ready for landing and surface operations, along with 200 scientists, Watkins said; all told, the team includes about 60 people whose prime job will be flying the spacecraft to Mars. The operations team will be almost entirely at JPL from landing day until about 90 days later.

After launch, the eight months spent cruising to Mars will be used productively. Watkins noted that operational readiness tests will be carried out during the early and middle parts of the cruise. During that time, the surface operations team and the entry, descent and landing team will finish up final procedures, processes and flight software.

Getting Curiosity to the launch pad has been a Herculean task, one that includes contributions from throughout NASA. Watkins praised the partnership and close working relationships developed between JPL and many other agency centers.

Besides Kennedy's involvement in launch preparation, Langley Research Center provided entry aerodynamics simulations and an entry, descent and landing instrument to assess the Martian atmosphere. Johnson Space Center contributed entry guidance system algorithms and expertise from the Apollo program, which will be particularly helpful in enabling the mission not only to target the geologically interesting Gale Crater landing site but also to hone in on the relatively small landing radius of about 10 kilometers (6 miles). Ames Research Center contributed both thermal-protection system expertise and test facilities, and portions of ground operations software, in collaboration with JPL's Division 31.

Goddard Space Flight Center built the largest payload element, the Sample Analysis at Mars suite of instruments, which will act as the rover's primary analytical laboratory.

Mars Science Laboratory's original launch was scheduled more than two years ago, but Watkins views "very positively" the extra efforts for testing and assuring the fidelity of the rover in the intervening time.

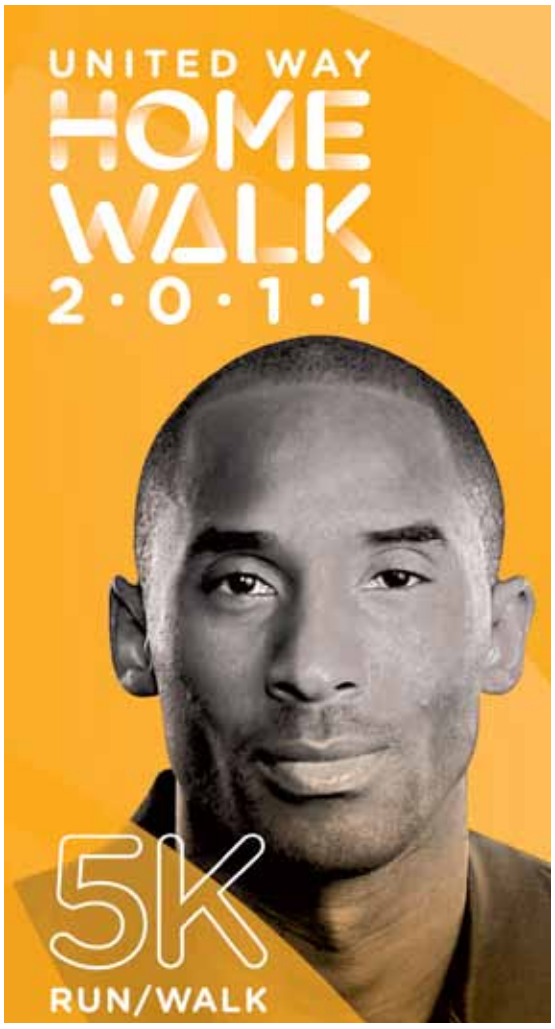
"It clearly gave us the time to build a much more robust mission and reduce risk in major areas," he said. "There's no question it was really necessary for the kind of mission we all want to have."

With the big run-up of activities to get ready for launch mostly accomplished, the team has "reached the top of the first mountain of several mountains to climb," Watkins noted.

"We recognize that understanding how to use this beautiful and complicated rover, and how to get the science we want out of it, is an enormous challenge, even with the experience of Pathfinder and the Mars Exploration Rovers behind us," he said. "In some ways we're smarter now; on the other hand, the complexity of the rover has gone up just as fast as we're getting smarter, and the expectations for what we can get done in terms of science have gone up just as fast as well."

The team's confidence is growing, Watkins said, but they're still mindful of the need to be extremely cautious.

"There's been a tremendous amount of progress made over the last couple of months," Watkins said. "The energy level and the amount of work that the team has done is just mind-blowing. It's been a long, long run to get here, but we have a long way to go."



United Way HomeWalk with Kobe Bryant Nov. 19

JPL employees are urged to consider joining a Caltech team that will participate in HomeWalk 2011, United Way's 5th annual 5K run/walk to end homelessness in L.A. County, on Saturday, Nov. 19 at Exposition Park. Basketball star Kobe Bryant will serve as honorary chair.

Employees and their families may sign up online at *http://www.homewalkla.org*. Those who pre-register to be a member of the Caltech team by Nov. 11 will receive an orange Caltech T-shirt. Registration fee is $25 per participant. United Way is asking each HomeWalk participant to raise at least $100.

The Nov. 19 event begins with check-in at 7 a.m. at 700 Exposition Park, Los Angeles, followed by opening ceremonies at 8:30 a.m. and the run/walk at 9 a.m.

According to United Way, 51,000 people in Los Angeles County are homeless, 40 percent of whom are women and children. Over the past four years, 18,000 HomeWalk participants have raised $1.7 million and funded organizations that have moved 9,000 people into permanent housing.

Beyond the annual autumn campaign, JPL is well represented in fighting poverty in the local community. Victor Luo of the Planning Software Systems Group and Stacey Boland of the Observatories System Engineering Group have been named to the United Way of Greater Los Angeles' Emerging Leaders Council.

"We discuss high-level goals of increasing community support of United Way's programs by hosting events with CEOs and other community leaders," noted Luo. "We also host mixers, which provide an opportunity for us to bring people outside of the organization to recognize the issues in our community and opportunities to directly lend a hand."

For more information on the leadership group, visit *http://www.unitedwayla.org*. Details on JPL's United Way campaign are available from Nancy Kapell at ext. 4-9432.

Saving costs with innovative data storage

By Janet Zadeh
Manager, Customer Care and Performance Management, IT Directorate

Meeting the ever-increasing information technology needs of JPL's science, engineering and business communities in a time of decreasing budgets presents the Information Technology Directorate with an opportunity for innovative solutions.

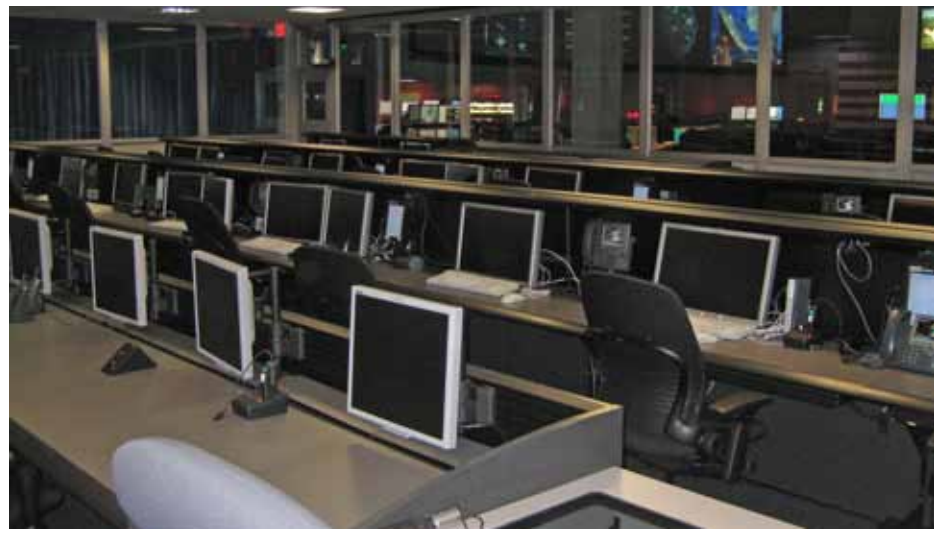
As the amount of data gathered by our scientists and generated by our engineers increases, the need to protect, process and store that data also increases. In the past, we would simply buy more and larger desktop computers, more and larger servers, more and larger storage devices, and build more and larger data centers. That solution, however, is no longer viable because, even though hardware costs have come down, labor costs as well as facility costs continue to climb.

To meet the need for data protection, the IT Directorate is assisting users with the selection of the most appropriate backup solution for their situation—often helping them move from a more costly service to a less costly one. Since March, more than 400 desktop users have moved from the backup service, which provides a robust backup solution more appropriate for servers, to the NearSpace backup, which makes use of storage included in the monthly hardware subscription. This effort has resulted in a total monthly reduction of just under $160,000, with a projected annual Labwide reduction of approximately $2 million.

To meet the need for more processing power, we are facilitating use of supercomputers at Ames Research Center. Complementing our on-Lab High Performance Computing capability with the much larger resource at Ames allows us to maintain the flexibility provided by local resources while improving our ability to run massive jobs outside.

This same flexible approach is guiding our data center strategy as we work to meet the need for increased storage and processing. The use of Cloud technology combined with the virtualization of hardware allows our storage and processing capacity to expand and contract as needed—without increasing either the size of our data centers or our inventory of hardware. Although not appropriate for all data, the Mars Exploration Rover project is making extensive use of this technology for storing and processing non-ITAR, non-sensitive data.

The concept of "shared services" is an important initiative designed to reduce the overall cost of information technology for JPL projects. Using common information technology infrastructure, including the JPL Network and the JPL Hosting Service, and the new Mission Infrastructure Service, projects like Mars Science Laboratory are able to reduce—and in some cases eliminate—their initial hardware costs as well as ongoing system administration costs.



Cost-saving services like the Mission Infrastructure Service, deployed in the Space Flight Operation Facility (above), help contribute to JPL's bottom line.

From the implementation of new technologies such as Voice over IP, projected to save the Laboratory $750,000 annually, to the development of information technology applications designed to make existing processes more efficient and less expensive to operate, the IT Directorate is partnering with individual users, organizations and projects to increase the use and effectiveness of information technology while reducing the unit cost.

In the future, longer desktop hardware replenishment options, the deployment of more Managed Desktop Environment subscriptions—currently saving the Laboratory approximately $110,000 per year—the increased use of Cloud technology, and the ability to "rent" non-core software applications, will continue this initiative.

Gale Crater awaits scrutiny

Mars Science Laboratory science team anxious to study landing site's diverse terrain for signs of habitability

By Mark Whalen

Gale Crater is a fascinating place to explore because of the mountain of layered materials in the middle. On Earth, this mound would be a mountain 5 kilometers (3 miles) high.

Life on Mars. Through the depths of human history, a subject of conjecture and wonder, in fantasy and in science. Could it be? Could it ever have been?

A JPL-led expedition is anxious to find out and is raring to go. If all goes well following its November launch, the Mars Science Laboratory rover Curiosity will set out on a 23-month mission in Gale Crater, a landing site containing a rich diversity of geologic features and considered a prime candidate as a potentially once-habitable environment.

Project Scientist John Grotzinger of Caltech and JPL leads a 200-researcher-strong, international science team that includes nine principal investigators representing the most sophisticated science payload to go to the Red Planet. About a dozen JPL researchers are co-investigators on the 10 instruments onboard the car-sized rover.

In addition to determining whether Mars ever could have supported life, the mission's science objectives are to characterize Mars' climate and geology and prepare for human exploration.

Grotzinger is quick to hedge on the mission finding clear signs of life. "We have no way to do life detection," he said. "That's very important to make clear. MSL will never know if there's a living organism on the surface of Mars. We have no experiment to do. In addition, we have no way to detect the presence of microfossils. They would be so small, that even if we detect organic carbon, we won't know that it's associated morphologically with a fossil microorganism."

Previously a scientist focusing on Earth sciences, Grotzinger's experience in looking for signs of microbial life in rocks billions of years old on Earth is sobering: "On a planet that teems with life it only very rarely is preserved in the rock record," he noted. It turns out that the very substance that enables life—water—is also an oxidant and during the conversion of sediment to rock, water circulates through pore spaces, binding mineral grains together but also oxidizing reduced carbon compounds. He expects the best hope lies in exploring rocks that precipitate directly from mineral-saturated fluids, such as the sulfates at Gale Crater.

Of course, Grotzinger said, the detection of organic carbon would be "a very exciting discovery. Even if it were abiotic, it would mean that the surface of Mars is able to permit reduced carbon to exist at the surface for some finite period." But what if Curiosity never discovered organic carbon? Here, Grotzinger is quite hopeful.

"Most realistically, our suite of instruments could measure a times series of geochemical variability through the stratigraphic record at Gale Crater, including trace and major elemental, mineralogic and isotopic measurements, and from that, understand the nature and evolution of surface environments on Mars across some relatively long interval of time almost 4 billion years ago. No record on Earth could ever compare with the very ancient age and extraordinary continuity of what is present in the 5 kilometer–thick stack of layers at Gale Crater. It may be unique in the solar system."

Grotzinger is looking forward to the capabilities of the Sample Analysis at Mars, or SAM, suite of instruments, which will study samples of soil and rock delivered by the rover's arm. One of the instruments, a tunable laser spectrometer, was built at JPL.

A key task will be measuring the isotope ratios of hydrogen, carbon, oxygen and maybe sulfur in sediments formed of mineral that precipitated from mineral-rich waters. Sulfur would be very interesting since sulfate rocks are so common on Mars. "Then we'll begin to understand the global geochemical cycle of sulfur on Mars, which is as important as carbonate is on Earth," Grotzinger said. These and other measurements such as trace elements and major elements will paint a picture of what the surface of Mars would have looked like, in a way that allows scientists to more directly compare it to Earth, he added.

"So even if we never found evidence for life on Mars, I think this kind of a picture would give us a better sense of the evolution of Earth as a separate terrestrial body from Mars. It is fascinating to consider the parallel evolution of two similar terrestrial planets, one that may have been abiotic and the other that has been so profoundly influenced by the presence of biology."

Grotzinger's interests since college have focused on the geobiological context of ancient environments on Earth, when life was first emerging and evolving. A significant keystone emerged during his research in the Sultanate of Oman in 2001 on the southeast coast of the Arabian Peninsula, when he came across rocks in the world's oldest commercially viable oil field—about 540 million years old, and spanning the time when animals first emerged—and studied them for their geochemical content and stratigraphy, in much the same way Curiosity will.

Later, as a professor in the Department of Earth, Atmospheric and Planetary Sciences at the Massachusetts Institute of Technology, Grotzinger got the chance to ply his trade on another world via his proposal for JPL's Mars Exploration Rover mission theorizing the presence of sedimentary rocks on Mars. As a participating scientist on the mission, he anxiously awaited the Jan. 3, 2004 touchdown of Spirit, the first rover.

"When Spirit landed, I saw lot of basaltic rocks and suspected that my contributions to the team might be both limited and brief," he recalled. "Then three weeks later Opportunity landed, and we saw all these sedimentary rocks, and the rest is history. That's why I'm here. For me, when those first few images came down from Opportunity, it was literally a life-changing event, in many regards."

Grotzinger and his family moved west in 2005. Besides his work on the rover mission, he's now a professor of geology at Caltech and is a member of the science team for the high-resolution camera on JPL's Mars Reconnaissance Orbiter.

The appeal of the Gale Crater landing site is multifaceted. The 3-kilometer-high mound of layered rock in the center of the crater is an alluring target, showing variations in both mineralogy and texture with elevation. Mars Reconnaissance Orbiter has identified clays in the lower layers,

Continued on page 4

MSL Project Scientist John Grotzinger.

News Briefs

Yoseph Bar-Cohen

Bar-Cohen pens seventh book

Yoseph Bar-Cohen, supervisor of the Advanced Technologies Group (355N) and a senior research scientist, is the coeditor and coauthor of "Biomimetics: Nature-Based Innovation," his seventh book.

The volume covers the current state of the art in biomimetics, documenting key biological solutions that provided a model for innovations in engineering and science. Biomimetics is the study of the structure and function of biological systems as models for the design and engineering of machines and materials.

"It is increasingly being recognized that nature is filled with effective inventions that can provide solution to numerous problems that humans encounter as well as provide ideas for technology improvements," Bar-Cohen said. "The emerging technologies can greatly benefit future NASA exploration missions."

The 788-page book is also the first in Bar-Cohen's new series, "Biomimetics." For more information, visit *http://www.crcpress.com/product/isbn/9781439834763.*

Hosts sought for seismometers

The Caltech Seismological Lab is seeking volunteers to host a hand-sized seismometer at home, as part of the Community Seismic Network project. The group is also interested in placing a few instruments in offices at JPL.

The lab aims to deploy more than 1,000 inexpensive devices across the greater Pasadena region to augment the existing five reference stations in the Southern California Seismic Network. This unprecedented deployment density and scale will allow a number of novel achievements.

Organizers say they will be able to collect and analyze block-by-block acceleration data and produce very fine-grained information for emergency services' first responders. In the aftermath of a major seismic event, emergency resources will be very thinly spaced and communications from citizens will be largely disrupted; these inhibit the best usage of scarce resources. The seismological lab will provide first responders with neighborhood data from right up to the moment when power and communications services collapse, noted Richard Guy, Community Seismic Network project manager.

Data will be used to provide very detailed information about the variations in shaking experienced within a small area, Guy said. "Inhomogenous behavior is known to be present at a regional level, and is believed to exist at 100-meter resolution; this project will provide sufficient data to study such claims. High-resolution tomographic studies of the ground under this region will also be feasible."

Caltech Seismological Lab devices are provided free of charge; volunteers simply need a stationary computer with 24/7 operation and Internet connection. For more information, visit *www.communityseismicnetwork.org*; e-mail *apply@communityseismicnetwork.org* or *rguy@gps.caltech.edu.*

Space telescope proposal funded

A JPL proposal to use a space telescope to survey more than 200 planets around other stars has been selected for funding by NASA.

Mark Swain of the Origins of Stars and Planets Group is principal investigator for the Fast Infrared Exoplanet Spectroscopy Survey Explorer, which would be the first mission dedicated to finding out what comprises exoplanet atmospheres, what conditions or processes are responsible for their composition, and how our solar system fits into the larger family of planets.

The proposal was one of 11 selected by NASA for evaluation as potential future science missions. The selections were made from responses to announcements of opportunity for Explorer missions released by the agency last November.

Also, an Explorer mission of opportunity funded for development includes participation by JPL's Paul Goldsmith, Jonathan Kawamura and Jorge Pineda. The Gal/Xgal U/LDB Spectroscopic/Stratospheric THz Observatory, led by the University of Arizona, would launch a high-altitude balloon with a one-meter telescope to provide a comprehensive understanding of the inner workings of the Milky Way galaxy and one of its companion galaxies, the Large Magellanic Cloud.

NASA plans to select up to two of the Explorer mission proposals and one or more of the five Mission of Opportunity proposals in February 2013. The missions would then proceed toward flight and some could launch by 2016.

Earth science proposal advances

JPL will lead a newly awarded proposal to be funded by NASA's Land-Cover/Land-Use Change Program.

Researcher Marc Simard of the Suborbital Radar Science and Engineering Group is principal investigator for "Vulnerability Assessment of Mangrove Forests in the Americas," a proposal to develop spatially explicit models of mangrove forest vulnerability to anthropogenic activity and climate change across the Americas. Models will be produced by integrating socio-economic datasets and local surveys with multi-sensor remote sensing of mangrove use and cover change, and eco-geomorphology.

Simard's proposal was in response to a call last year from the NASA Science Mission Directorate's Research Opportunities in Space and Earth Sciences Program. NASA received 25 Step-2 proposals and selected seven proposals for funding. For more information, visit *http://nspires.nasaprs.com.*

Caltech co-op preschool to open

The Child Educational Center has announced the launch of a cooperative, parent participation preschool at Caltech. Parents will participate directly in their child's play and educational experience by working in the preschool environment and assisting the teachers in implementing the curriculum.

Applications are now being accepted for children from 2 years, 9 months old through 5 years, 11 months. Priority enrollment will be given to Caltech and JPL postdocs and graduate students, followed by staff and faculty. Program hours are 8:30 to 11:30 a.m. daily during the academic school year.

To learn more, visit *http://www.ceconline.org* and click on the link to the Cooperative Preschool page.

MARS SCIENCE LAB *Continued from page 3*

inter-bedded with sulfates higher up. Both are thought to involve liquid water in their formation, but the nature of the water and other chemistry on Mars' surface would be quite different as each formed. "By driving up the Gale mound and sampling each layer, we will be reading a book of the early environmental history of Mars. The Gale mound is the biggest such book we can find on Mars, offering the best place to search for habitable environments," noted Deputy Project Scientist Ashwin Vasavada. "It's going to be a great adventure."

Grotzinger expressed his appreciation for the "amazingly difficult process" it's been to build the rover. "On behalf of the science community, I feel an incredible debt of gratitude to every person who worked on this project," he said. "Because without this effort, we wouldn't be launching.

"People wonder about the $2.5 billion price tag, but if you divide that by every man, woman and child in the country, it's like the price of going to a movie. To me, it's totally worth it."

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

Universe

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Production
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Photography
JPL Photo Lab

Universe is published by the Office of Communications and Education of the Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91109.

Passings

Boris Seidel, 75, a retired group leader in the Antenna and Microwave Development Group, died Aug. 21.

Seidel, who joined JPL in 1962, was instrumental in the development of the Deep Space Network Microwave Antenna Holography System that was applied to a newly constructed 34-meter beam-waveguide antenna at Goldstone, Calif. He retired in 2001.

Seidel is survived by his wife, Diane; sons Michael and David (and wife Cathy); and grandson Nathan. Seidel's family requests consideration of contributions in his memory to the City of Hope.

Robert Beale, 79, a retired propulsion development engineer, died Oct. 2.

Beale joined the Lab in 1959 and retired in 1997. In 1982 he was awarded NASA's Exceptional Service Medal for his skill in leading efforts to develop more efficient and less costly methods of converting solar energy to electrical power.

Beale is survived by his wife, Laurel; children Melissa Carson, Philip Beale, Eric Beale and Christine Riedy; grandchildren Eian, Kari, Samantha, Maggie, Kate and James.

A memorial service was held Oct. 15 at Trinity Episcopal Church in Escondido, Calif.

Tage Anderson, 85, a retired electrical engineer, died Oct. 12.

Anderson joined JPL in 1963 and retired in 1993 as a member of the Space Communication Data Systems Section.

He is survived by his wife, Diana; daughter Joanne Nelson; brother Gösta; and niece and nephew Carina and Håkan.

A memorial mass was held Oct. 21 at St. Rita Catholic Church in Sierra Madre. Anderson's family requests consideration of donations in his memory to Parkinson's disease research; e-mail *info@pdf.org.*

Rich Morris

John Richard "Rich" Morris, 37, who served numerous roles on JPL's Mars rover projects, died Oct. 18.

Morris had worked at the Lab since 2001. For the Mars Exploration Rovers he served as tactical activity planner/sequence integration engineer, tactical uplink lead and mission manager. He had worked on Mars Science Laboratory since 2008 as a sequencing software cognizant engineer.

Services were held Oct. 27 in Oklahoma City. Contributions in Morris' memory may be made to the Oklahoma City Community Foundation, P.O. Box 1146, Oklahoma City, OK 73101.

Letters

Jan and I want to thank everyone for their support following the recent passing of her father. The plants are beautiful.

Pat Beyer

Retirees

The following JPL employees retired in October:

Gary Parks, 35 years, Section 7400; **William Eggemeyer**, 33 years, Section 317F; **Richard Southern**, 30 years, Section 333G; **Narayan Mysoor**, 26 years, Section 337F; **Susan Green**, 24 years, Section 3410; **Roger Klammer**, 16 years, Section 5122.