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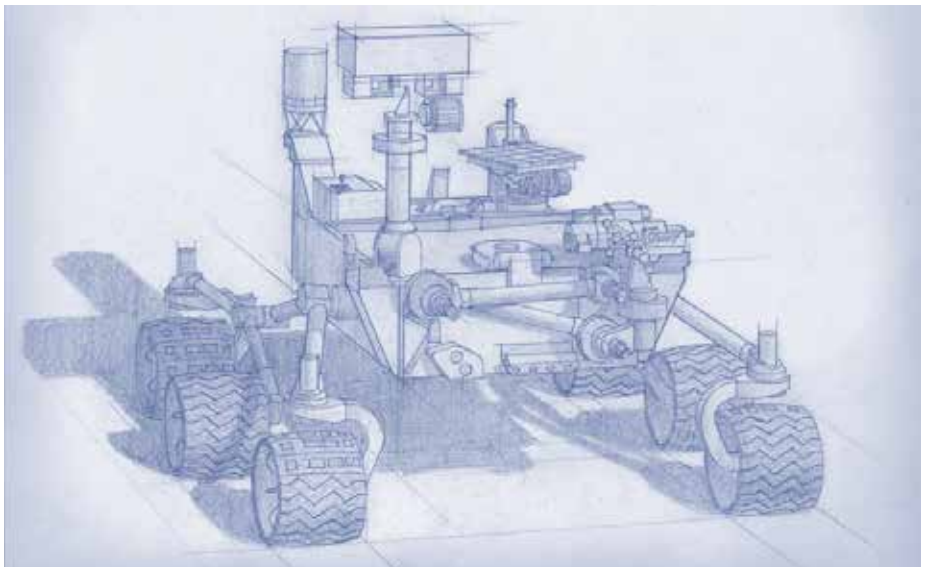


Planning for the 2020 Mars rover envisions a basic structure that capitalizes on the design and engineering work done for the Curiosity rover but with new science instruments selected through competition for different science objectives.

Mars 2020 rover to continue search for habitability

By Mark Whalen

Mission will demonstrate collection and storage of samples for return to Earth

As JPL celebrates the landing of Curiosity on Mars one year ago in August, planning for a new mission to deliver the next rover to the Red Planet is well underway.

The Mars 2020 rover mission will take the next steps in the search for whether the planet has ever supported life by exploring a habitable environment and gathering rock and soil samples for a possible return to Earth by another future mission.

"The science community has been dreaming for decades about bringing samples back," noted Project Scientist Ken Farley of Caltech. "It's going to be a long road, but it'll be really important to our understanding Mars and the solar system when we get samples back."

The mission's suite of instruments will be determined by next spring through a competitive announcement of opportunity. Meantime, a team working on defining the mission's science suggests that the rover include capabilities for unprecedented in-situ analysis of rock and soil samples.

To help determine drilling targets, the team said the rover should have the ability to analyze samples at microscopic levels to look for features that may have been formed by past life.

Rather than creating powder of rock samples—as Curiosity's drill does—the drill on the 2020 rover will extract cores from the uppermost few centimeters of the surface of rock where life may have existed—for example, at the site of a onetime lake.

The rover will deliver a cache of 25 to 30 samples of rocks weighing a total of about half a kilogram, Farley said. Each core sample will go into individual tubes

Continued on page 2

Curiosity celebrates a year on Mars

By Mark Whalen

Could it be a year already? The raucous and triumphant celebration during the late-night hours of Sunday, Aug. 5, 2012, when space fans worldwide welcomed the Curiosity rover to the surface of Mars, is still a vivid memory for many JPLers. Universe caught up with some of the key players who made Mars Science Laboratory happen.

Q What were the best surprises for you during the experience? When did you first realize that the mission was truly hitting a payday and has been worth all the work and sacrifice?

Ashwin Vasavada, project scientist: Our science team worked incredibly hard to choose the best site possible to understand Mars' early environment and suitability for life. But there's only so much you can figure out from orbit, even with those amazing Hirise images. I think most of us were stunned when we first got Curiosity's telephoto lens on Mt. Sharp. It was everything we hoped for scientifically. But even more, it was gorgeous, and so Earth-like.

Justin Maki, engineering camera cognizant engineer, mastcam deputy principal investigator and Hand Lens Imager/Mars Descent Imager co-investigator: Everyone knows about the "Seven Minutes of Terror," but for me there was an eighth minute of terror: waiting for the first Hazcam images after landing. While most of the team in the control room was celebrating and high-fiving, I was still at my console waiting for the first few bits of image data to trickle in. My computer monitor was being projected live onto the control room screen, so my task on landing night was to get the picture displayed as quickly as possible. When the images came down, it was definitely memorable.

Betina Pavri, lead payload downlink coordinator: The most exciting thing for me so far is the discovery that—sometime in the past—there was flowing water on the surface of Mars at Curiosity's location in Gale Crater. The water was flowing long enough, and was vigorous enough, to round off rocks, like we see in streambeds on Earth. That's a fascinating result.

Al Chen, entry, descent and landing flight dynamics and operations lead: Aug. 5 changed everything. Now, I find myself working the 2020 mission, which specifically calls for the reuse of Curiosity's landing system. What seemed so unimaginable a year ago now seems to everyone to be the next logical step. The successful landing of Curiosity was obviously a payday in itself for those of us who worked 10 years to get seven minutes to go right. But the decision to double-down on the landing system for 2020 is an especially sweet validation of all of our efforts.

Anita Sengupta, supersonic parachute systems engneer on the entry, descent and landing team: The best surprise is the outpouring of excitement, interest and wonder from the general public and students. Much of the public, I believe, truly understands the value, importance, challenge and accomplishment of space exploration because of Curiosity—not only as a national endeavor, but as a human endeavor. After the landing I began to realize how much support and affection we had with the outpouring of interest via social media. Landing night was the ultimate "payday" for me.

Continued on page 2

MARS 2020 *Continued from page 1*

that are inserted in the cache, which will help scientists keep track of notes on how the sample was collected.

"That's what's special about the ability to bring chosen samples back," Farley said. "We'll know exactly where they're from, to see how they fit in relation to features that we can identify and characterize with the rover's instruments."

The mission builds on a heritage of success, as it will reuse much of the engineering and design of the Curiosity rover, flight system and skycrane, said Project Manager John McNamee. Enhanced capabilities will be added as the mission's requirements mature, he added.

The $1.5 billion mission is targeted for launch in July or August 2020, with landing between January and March 2021.

McNamee said a key milestone for the team is a mission concept review at JPL Aug. 6 and 7. A mission definition review will follow in about a year.

About 70 to 80 JPLers are currently at work full-time on the mission, a number that will increase to between 400 and 500 by 2017-18. The core staff will be Mars Science Laboratory veterans, including Matt Wallace, the deputy project manager, who also worked on the Mars Exploration Rovers and Mars Pathfinder.

"We have stockpiled as much of the residual Mars Science Laboratory hardware as we can and are identifying issues of high risk, in terms of parts obsolescence and the like," added McNamee, who praised the documentation carried out by the Curiosity staff. "It's not just hardware and software we're inheriting. They have done a very nice job."

The 2020 rover's objectives also call for it to demonstrate how natural resources on Mars can be used by future human missions. This experiment would be conducted by NASA's Human Exploration and Operations Mission Directorate.

NASA said the decision on when and how to return Martian samples to Earth won't be made until a later date. Mars sample return was identified as a top priority by the National Research Council's planetary science decadal survey in 2011.

The mission "will deliver a lot of exploratory science in an area that will be different from anywhere else we've been on Mars," Farley said. "Even if we don't bring a cache back, there will certainly be important scientific returns."

CURIOSITY *Continued from page 1*

Q What is the best lesson you learned?

Vasavada: As a project scientist, my job has been just as much about people as about science. I've learned a lot from managing a team of 400+ scientists, each with their own personality, passion and way of contributing. I'm learning to find the right balance between leading and facilitating, allowing everyone to express their view but also developing consensus quickly, since our clock is always ticking.

Sengupta: That you really can do anything in life if you put your mind and heart in it. The more difficult the problem, the more interesting and fascinating the journey to find the solution. My career has already benefited because I took on a significant technical challenge and was successful. As you grow as an engineer you grow as a person.

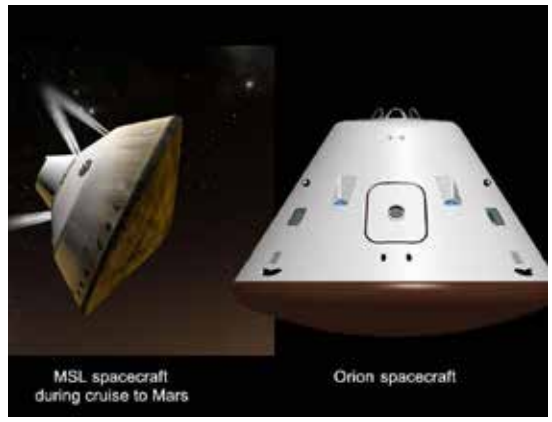
Curiosity's top five science discoveries

1. A suitable home for life

According to the MSL project, Curiosity's top finding was that Mars could have the right chemistry to have supported living microbes, discovering sulfur, oxygen, phosphorus and carbon—key ingredients necessary for life—in the powder sample drilled from "John Klein."

2. Evidence for an ancient streambed

The rocks found by Curiosity are smooth and rounded and likely rolled downstream for at least a few miles. The exposed bedrock above tells a story of a steady stream of flowing water about knee deep.



3. Radiation could pose health risk for humans

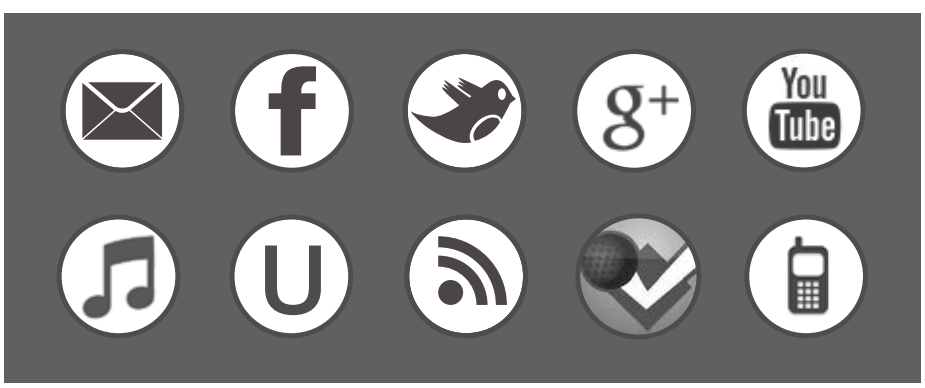
Curiosity's radiation assessment detector took measurements on the flight to Mars and continues to take measurements on the surface. The findings will be used to explore different approaches for safe human space missions and habitats. Above: the Mars Science Laboratory spacecraft during cruise to Mars (left) and the Orion spacecraft.

4. The hunt for elusive methane

Scientists using Earth-based detectors have reported finding methane in the Martian atmosphere. Since landing, Curiosity has found none. It could be that methane is emitted from just a few places on Mars, or just in certain seasons.

5. Diverse environments abound

Curiosity found many diverse signs of a watery past near its Gale Crater landing site. Water-transported sand dunes and water-cemented gravel were among the sites to wow scientists as Curiosity explored the area.



The public impact

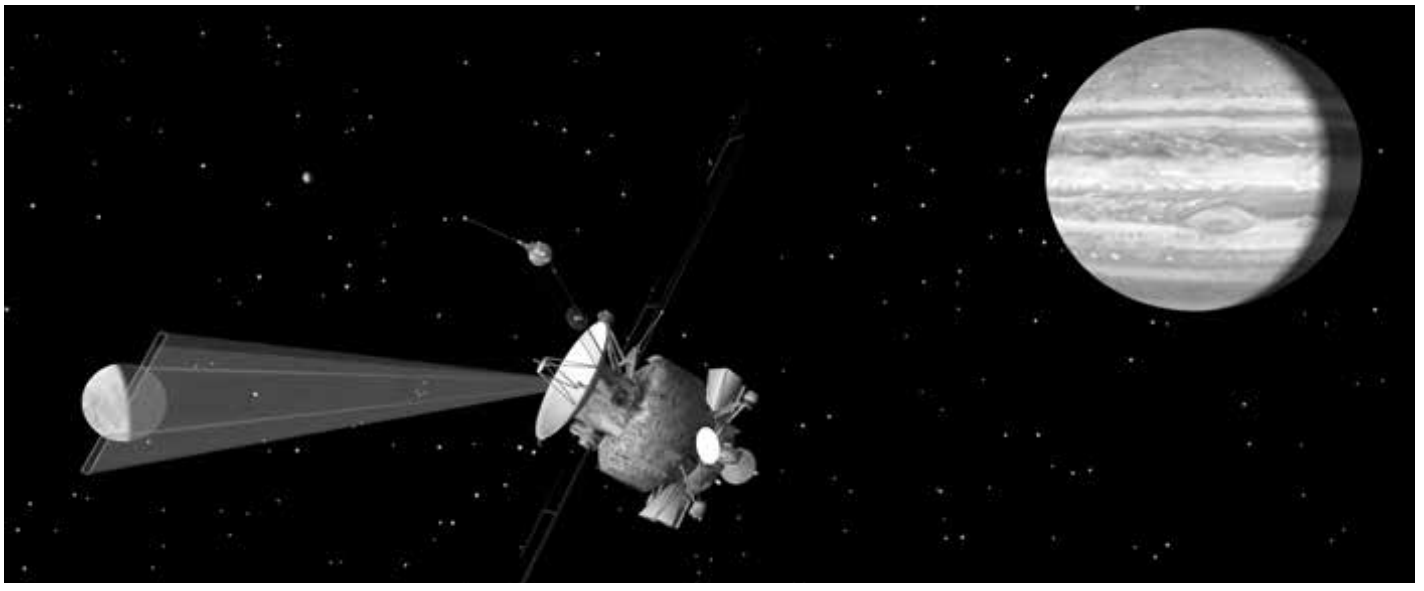
One year later, Curiosity remains incredibly strong among social media fans, said JPL Media Relations Office Manager Veronica McGregor.

She noted the sustained interest in the rover's Twitter account, which now has about 1.3 million followers, and Facebook page with half a million "Likes."

JPL also took top honors this spring in three of the most prestigious awards for social media, McGregor said, noting the South by Southwest (SXSW) Interactive Award for Best Social Media Campaign, Shorty Award for "Foursquare Mayor of the Year" and a Webby for Best Overall Social Presence. "For the Webby, JPL beat some tough competition, including HBO True Blood, the New York Times, the London Olympics, the New Yorker, GQ.com, MTV, Anderson Cooper and the Discovery Channel," McGregor said.

For many people, following the activities of Curiosity has rekindled or sparked interest in other aspects of JPL's and NASA's programs, she added.

Does Jupiter moon hold the best hope for life?



Studies continue for Europa Clipper mission in early 2020s

By Mark Whalen

JPL scientist Kevin Hand is a technical consultant for "Europa Report," a movie releasing this month that chronicles a future astronaut journey to the moon of Jupiter seeking to make the first discovery of life beyond Earth.

But for Hand, this fictional mission may not be a fantasy. He is among a select group looking hard at the feasibility of conducting such a mission—save for the astronauts—early next decade.

The idea fits right in with the National Research Council's most recent planetary decadal survey that rated Europa as a high priority. The JPL concept, the Europa Clipper, is under study and is working toward a 2021 launch.

The study team plans to hold a preliminary mission concept review next February. A formal concept review is tentatively planned for September 2014, said Goldstein, which could make the project ready to enter phase A in fiscal year 2015.

"My goal is to find life beyond Earth," said Hand, who has taken a key role in recent Europa studies. "And if Earth has taught us anything, it's that where you find water, you find life. We know now of several liquid-water oceans existing beneath the icy shells of the moons of the outer solar system. And among those worlds, Europa is the prime place to go and look for life beyond Earth—living life."

Besides Europa, Jupiter's moons Ganymede and Callisto are also thought to have subsurface oceans, noted Project Scientist Bob Pappalardo. Europa's ice caps are much more shallow than those at the other two moons, allowing for easier access, and probably are geologically active today, he said.

"There's hope that [Europa's] ocean and the surface are exchanging materials, and that oxidants on the surface could potentially get into the ocean to be a food for life," Pappalardo said. "That doesn't apply to the other moons. So when we said Europa, it's not just because we thought Europa was cool. When you're looking for a place to go to understand if there could be life there, and ultimately to be able to look for it from the surface from a future lander, it's the place to go."

The current mission plan also includes flybys of Ganymede and Callisto, but Europa will be the focus, with 45 orbital encounters planned.

The launch date for the mission depends on how the spacecraft gets to Jupiter, said Project Manager Barry Goldstein. An Atlas-class rocket could launch it on a time-tested Venus-Earth-Earth gravity-assist trajectory; windows for such a launch open once every 13 to 15 months. But a new rocket being developed under NASA's Space Launch System could provide a much quicker alternative.

The Space Launch System could get the spacecraft to Jupiter "in a little bit under two years," Goldstein said. "We could have launch opportunities approximately every 12 months, the earliest one being June 2022. Compare that to the Atlas launch in November 2021, which would take six and a half years." Going with the Space Launch System, he said, "shaves at least four and a half years from the cruise, a substantial improvement."

Key among the myriad challenges in this first-of-its-type mission are concerns about planetary protection and the effects of radiation on the spacecraft.

"On missions such as [Mars] Phoenix, we were looking for organic material, the building blocks of life," noted Goldstein, who was also the Phoenix project manager. "You want to make sure not to bring anything with you that would give you a false-positive reading to that effect. However, the challenge is as great or greater for Europa, where we are concerned about forward contamination impacting a possible ecosystem."

Spacecraft safety is critical as well.

"It's been a long time since we've done a mission that's experienced the kind of radiation environment that we're going to see with the Europa Clipper," Goldstein said. "We have to make sure we have high-reliability parts, and that the payload can maintain the integrity it needs."

JPL is partnering with the Johns Hopkins University Applied Physics Laboratory on the mission. Currently, about 50 JPLers are on the development team, which expects to add another 25 or so in the next few months.

"This is just to get to the mission concept review phase," said Goldstein, noting that the team is working on system engineering and architectural design, science requirements and payload accommodation issues. "We also have a significant mission design team working the very complicated and difficult orbit trajectory that we have to master to get the passes around Europa to get the science accomplished."

Support from the science community for a Europa mission is clear, but the most important advocates are in Congress. On a positive note, the House Appropriations Committee's draft language for NASA's 2014 budget includes $80 million for a Europa reformulation study and an announcement of opportunity for instrument development.

"While we're not an officially approved project, clearly we have significant advocacy in terms of support from Congress, but also, very notably, the support of the science community," said Goldstein. "We're very optimistic that we will get our formal start if not next year then the year after that."

"If life is out there in our solar system, I'm quite convinced that Europa is the best place to look," Hand said. "This mission may not find that life, but it will characterize Europa in a way that it could make an incredibly compelling case for Europa not just being habitable, but potentially inhabited."

Spots and shallow pits pepper the ridged surface of Europa in this 2002 view combining images taken by JPLs' Galileo spacecraft during two different orbits around Jupiter. The spots and pits visible in this region of Europa's northern hemisphere are each about 10 kilometers (6 miles) across.

News Briefs

Ellen Stofan

Former JPLer named NASA science chief

Former JPL research scientist Ellen Stofan has been named NASA's new chief scientist, effective Aug. 25.

Stofan worked at JPL from 1989 to 2000, during which she was deputy project scientist for the Magellan mission to Venus; chief scientist of the New Millenium Program; and an experiment scientist on the Spaceborne Imaging Radar-C mission.

Most recently, she served as senior research scientist and vice president of environmental consulting company Proxemy Research in Maryland.

Stofan earned a bachelor of science degree in geology from the College of William and Mary in 1983 and a Ph.D. in geological sciences from Brown University in 1989.

Advanced technology concepts awarded

Two JPL proposals were among 12 selected by NASA for study under Phase I of the NASA Innovative Advanced Concepts Program, which aims to turn science fiction into fact.

Hamid Hemmati is principal investigator for "Two-Dimensional Planetary Surface Landers," which proposes to develop a new landing approach that significantly reduces development time and obviates the most complicated, most expensive and highest-risk phase of any landing mission.

The concept calls for a blanket- or carpet-like two-dimensional lander with a low mass/drag ratio, which allows the lander to efficiently shed its approach velocity and provide a more robust structure for landing integrity.

For more information, visit *http://www.nasa.gov/content/two-dimensional-planetary-surface-landers/#.Uel9au-DOsX5.*

Adrian Stoica is principal investigator for "Transformers for Extreme Environments," which proposes a revolutionary way to remotely control the environment surrounding one or more roving vehicles.

The plan includes multifunctional platforms that can change their shape and function to reflect solar energy, warm and illuminate targets, power solar panels, track movement and act as a telecommunications relay.

For more information, see *http://www.nasa.gov/content/transformers-for-extreme-environments/#.UemCbeDOsX5.*

For a complete list of the selected proposals and more information about the Innovative Advanced Concepts Program, visit *http://www.nasa.gov/niac.*

Herschel instrument team honored

The team behind the Herschel spacecraft's spectral and photometric imaging receiver instrument has been awarded the 2013 Sir Arthur Clarke Award for academic study and research.

The instrument is one of three on the European Space Agency spacecraft, which was launched in 2009 and operated until the end of its scientific mission in April of this year. JPL developed and built the "spider web" bolometers for the instrument, which are 40 times more sensitive than previous versions.

JPL also developed and built mixers, local oscillator chains and power amplifiers for Herschel's heterodyne instrument for the far infrared (HIFI).

Over its nearly four years of operation, the spectral and photometric imaging receiver instrument revolutionized understanding of the universe as seen in far-infrared and sub-millimeter light. It has studied the formation of stars in our galaxy in unprecedented detail, including making a map of the entire Milky Way and the nearby Andromeda Galaxy. It has imaged a quarter of a million galaxies out to distances billions of light years, as well as a host of planets, asteroids and comets within our own solar system.

The awards, presented at a United Kingdom space conference in July, are organized by the Arthur C. Clarke Foundation and the British Interplanetary Society.

Five JPLers named to academy

Five JPLers were recently elected as new corresponding members of the International Academy of Astronautics.

Jakob van Zyl (associate director, project formulation and strategy), Carol Raymond (Small Bodies Program Office manager) and Bob Pappalardo (Europa Clipper project scientist) were named to the Basic Science Section, and Leslie Livesay (engineering and science director) and Adam Steltzer (Systems Engineering and Formulation Group) to the Basic Engineering Section.

The five join nine current and eight retired JPL members, including former JPL Director Ed Stone, a past academy president. The current president is Mahdevan Nair, who recently led the Indian space program. The organization was founded by JPL founder Theodore von Karman.

For more information, visit *http://iaaweb.org/content/view/134/232.*

Optics society promotes Ting

David Ting, a senior research scientist and a principal member of engineering staff from the Infrared Photonics Group in Section 389, has been promoted to Fellow of the International Society for Optics and Photonics.

Ting was honored for significant service to the society and to the greater science community, as well as recognition of noteworthy technical achievements.

He works in semiconductor physics and device research, with interests that include spintronic devices, solar cells, lasers and infrared detectors. His contributions in the development of the barrier infrared detector played a pivotal role in propelling JPL to the forefront of quantum structure infrared detector technology, the society noted.

Poster honors for postdoc researchers

Five JPLers have been recognized for presenting the top poster highlighting postdoctoral scholars' work over the past year.

At the annual Postdoc Research Day July 9, 45 postdocs presented their research to the JPL community. Of the posters presented, five were selected for recognition. Poster authors each received an engraved plaque and an opportunity to summarize their research at an awards ceremony in September.

The award recipients, with work organization, category, poster title and adviser:

Ingunn Wehus (3267), Astrophysics and Space Science: "Planck Component Separation With Commander," Charles Lawrence, adviser.

Jae-Hong Moon (3244), Earth Science: "Multi-Decadal Sea-Level Shift In The Pacific From 1958 to 2008," Y. Tony Song, adviser.

Panagiotis Vergados (335G), Earth Science: "Inside Tropical Cyclones With GPS: A New Perspective," Anthony Mannucci, adviser.

Heidar Thrastarson (3225), Planetary Science and Life Detection: "General Circulation and Variability of Close-In Exoplanet Atmospheres," Pin Chen, adviser.

Carl Borgentun (389K), Technology, Instrumentation and Engineering: "High-Power Semiconductor Lasers For In-Situ Sensing Of Atmospheric Gases," Siamak Forouhar, adviser.

Winners will be honored at a postdoc awards ceremony on Sept. 4 from 9 a.m. to noon in 180-101.

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Passings

Gloria Goodwin, 91, a retired PBX operator supervisor, died June 21.

Goodwin joined JPL in 1961 and retired in 1980.

She is survived by children Vicki Garrett, Sally Williams and Gary Clark; eight grandchildren and six great-grandchildren. A celebration of life will be held in her honor this summer.

Gloria Goodwin

Retiree **Samuel Brunstein**, 83, died June 23.

Brunstein worked at JPL from 1986 to 1995. He is survived by his wife, Marie, and stepchildren Jim, Eric and Laura.

Cremation was performed by the Neptune Society in Arizona.

Robert Norman, 96, a retired mechanical engineer, died July 20.

Norman worked at JPL from 1957 to 1982. He contributed to numerous JPL projects, including Viking, Voyager, Galileo and the Mariner missions.

Pre-deceased by his daughter Diana, Norman is survived by his wife, Laurel Ann; daughter Cynthia Norman Klinger, granddaughters Robin and Jamie, and a great-granddaughter.

Correction

In the July 2013 issue of Universe, a caption with a photo of a presentation of a NASA systems-engineering excellence award contained incorrect information. The photo shows JPL Engineering and Science Director Leslie Livesay and NASA Chief Engineer Mike Ryschkewitsch presenting the Dawn flight team's award to mission director Marc Rayman.

Letters

I would like to say thanks to my JPL colleagues for their outpouring of sympathy and well wishes following the recent passing of my grandmother. From surviving the Dust Bowl in western Kansas to watching us land Curiosity a month after her 100th birthday, she certainly had a full life. May she now rest in heavenly peace.

Todd Barber

Thanks to JPL for the beautiful plant that was sent to me for the passing of my father. I would also like to thank my colleagues in Section 392 for the thoughtful sympathy card. I greatly appreciate your thoughts, prayers and support during this time.

Cliff Helfrich

My family and I would like to thank everyone in the Facilities Division for their comforting condolences at the passing of my mother and for the generous memorial sent in her remembrance. We would also like to thank JPL for the beautiful plants. Everyone's kindness and generosity is truly appreciated and gratefully acknowledged.

Linda Kyle

Retirees

The following employees retired in July:

Krista Kelly, 44 years, Section 921; **Andrea Stein**, 35 years, Section 274; **Diane Fisher**, 30 years, Section 172A; **Michele Bell**, 26 years, Section 349D; **Judith Nelson**, 23 years, Section 3917; **Edward Barlow**, 21 years, Section 347A.