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Dutch Slagter / JPL Photo Lab

Aquarius Project Scientist Yi Chao says the science community has hoped for the instrument's debut for decades.

Aquarius to scrutinize ocean salinity

By Mark Whalen

International mission due for June 9 launch from Vandenberg

Another key piece in Earth's climate-change puzzle is about to emerge with the June 9 launch from Vandenberg Air Force Base of the Aquarius instrument, jointly developed by JPL and Goddard Space Flight Center. The first NASA instrument to measure ocean-surface salinity from space, Aquarius will assess the critical interactions between ocean circulation, climate and the global water cycle.

A collaboration between NASA and Argentina's space agency, Aquarius is the primary instrument aboard the international Aquarius/SAC-D observatory. SAC stands for Satelite de Applicaciones Cientificas. The observatory carries seven other instruments that will collect environmental data for a wide range of applications, including studies of natural hazards, air quality, land processes and epidemiology.

Aquarius Project Scientist Yi Chao provides a mission preview.

Q: WHY IS OCEAN SALINITY SO IMPORTANT TO STUDY?

Salinity and temperature determine the density of the seawater, and the weight of the seawater plays a key role in driving ocean circulation, such as water overturning in a vertical direction like the gulfstream moving water from the tropics to the poles and then getting cold and sinking to the bottom. That plays a key role in regulating climate, weather and atmospheric conditions.

Also, salinity has a key role in linking with the water cycle. When there is rain, fresh water is dumped into the ocean and the salinity is decreased. Near the coastal areas, fresh water runoff from rivers also decreases salinity, as will melting ice. So, basically, salinity is an indicator of the water cycle from our oceans to the atmosphere, to the rivers, to the land—and all the water eventually has to cycle through the ocean.

Satellites can measure ocean-surface properties such as temperature, winds, sea level, productivity and color. Salinity, the variable, has been requested by the Earth science community for a long, long time to measure from space; it has been the dream in the community for at least three decades.

Q: WHY HAS IT TAKEN SO LONG?

The salinity signal from the ocean surface that can be measured from space is really, really small—sometimes smaller than the "noise" that contaminates any remote-sensing technique. It's taken almost a decade to understand the principal of salinity remote-sensing, almost another decade to understand how to improve these corrections for data retrieval, then finally another decade to put the instruments together from airplane and laboratory tests.

Q: HOW HAS OCEAN SALINITY BEEN MEASURED THUS FAR?

The first measurements were made more than 150 years ago when people on boats collected seawater samples in a bucket and then measured the temperature and salinity on board. Now salinity is routinely measured by research or commercial ships, but they are very expensive, so they are limited to very few locations.

About 10 years ago, autonomous uncrewed underwater vehicles were developed to provide many different measurements without being maintained by people. These devices cost about $20,000, also pretty costly. Right now about 3,000 of them are deployed in the ocean. That sounds like a lot, but they have to be placed hundreds of kilometers apart in order to cover the entire globe. More importantly, certain areas—such as the southern ocean around the Antarctic continent—are difficult to access and still remain poorly mapped.

Q: SO WHERE DOES AQUARIUS COME IN?

As a NASA Earth Space Science Pathfinder mission, Aquarius needs to demonstrate that this kind of technology from space can be made successfully in the future—much like measuring sea levels with TOPEX/Poseidon led to Jason-1, Ocean Surface Topography Mission/Jason-2 and their follow-ons.

Because much of the ocean has never been densely measured before, having routine measurements for good coverage of the globe leads us to expect the community will discover something interesting and new. That's what makes this mission exciting and different.

We also expect to have more breakthroughs where we see a lot of salinity signals. In the Indian Ocean, a lot of rain falls as part of the seasonal cycle; in the Pacific there's the El Niño phenomena. Those type of climate variabilities have a signature of salinity that has not been well mapped before. With Aquarius, we will get a global map of salinity every seven days.

Also, one of the exciting questions the community wants to see answered is, after hurricanes, what happens to the oceans? A tremendous amount of heat is lost in a hurricane because it has an intense interaction with the ocean and the atmosphere, resulting in a decrease of 2 or 3 degrees Centigrade (about 35 to 37 F) after the hurricane passes. There should be a pretty significant salinity wake as well. Potentially, this is another discovery we want to map. The routine salinity measurements from Aquarius should enable the modeling community to improve climate models and reduce forecast uncertainty.

Q: HOW WILL AQUARIUS DATA BE USED?

Besides the science team competitively selected by NASA Headquarters, the data can be employed by customers who will use it to make day-to-day decisions. For example, one group we are interacting with is the National Center of Environmental Prediction, which produces El Niño predictions on a weekly basis for the National Oceanic and Atmospheric Administration.

We are already thinking ahead for societal applications. We would like to speed up that process and the time period to transition from research to practical application.

Goddard will manage the operational phase and handle the ground data salinity processing. Aquarius data will be distributed and archived by the JPL Physical Oceanographic Distributed Active Archive Center.

Q: HOW MANY JPLERS ARE ON THE TEAM?

There are so many people at JPL who contributed to Aquarius during the last decade. At the peak of the implementation phase, there were more than 50 people involved at JPL from all the technical divisions. Today, about 30 people are working on the various components of the mission.

Q: PERSONALLY, YOU ARE QUITE INVESTED IN THIS QUEST.

I was hired in 1993, a few months after the launch of TOPEX/Poseidon, to work on that mission, and then I worked on the QuikScat scatterometer. I'm very excited participating in Aquarius from the start and seeing how JPL continues to sustain a leadership position in satellite oceanography.

We saw something interesting at JPL's recent open house. As soon as you mention climate, everybody knows. Not too long ago, hardly anybody in the public paid attention to the topic of climate change. We explained Aquarius' mission as a missing piece of the climate-change puzzle, and everybody gets it. So it's perfect timing.

2011 Open House

More than 38,000 visitors attended the Lab's annual Open House on May 14–15. The public got a final look at Mars Science Laboratory's Curiosity rover before it ships to Florida for its launch next fall. JPL also showed off its new Earth Science Center in Building 264. More pictures are available at *http://goto/open-house.*

Photos by Brad Graverson

Farewell to Spirit

By Franklin O'Donnell

Operations end for robust rover that achieved for seven years

It was the Mars rover that lived up to its name. For years since landing in 2004, Spirit delivered a treasure chest of science findings, revealing the region it explored as a hot, violent place early in Mars' history, with hot springs, steam vents and volcanic explosions. As time went by, Spirit battled problems such as a lame wheel before becoming mired in a sand trap. More than a year ago, it fell silent.

Since then the mission team continued trying to contact Spirit, but after the Martian summer arrived this year with no word from the rover, in late May they announced it was time to say goodbye to the robotic explorer. The team ended operational planning for Spirit and transitioned the Mars Exploration Rover project to focus on its still-active twin, Opportunity.

The first of the two rovers to arrive at Mars in January 2004, Spirit bounced to the surface in Gusev Crater, a 166-kilometer-diameter (100-mile) dish thought to be an ancient lakebed. In the year that followed, it drove 7.73 kilometers (4.8 miles)—more than 12 times the goal set for the original 90-day primary mission—and sent to Earth more than 124,000 images. Crossing a plain to reach a distant range of hills, Spirit became the first robot to scale a hill on another planet when it reached the summit of Husband Hill. After its right front wheel became immobile in 2006, it continued to move, covering nearly a kilometer (more than half a mile).

Dragging the stuck wheel while driving backwards, Spirit made one of its most important science discoveries. The immobile wheel plowed up bright white soil, which proved to be nearly pure silica.

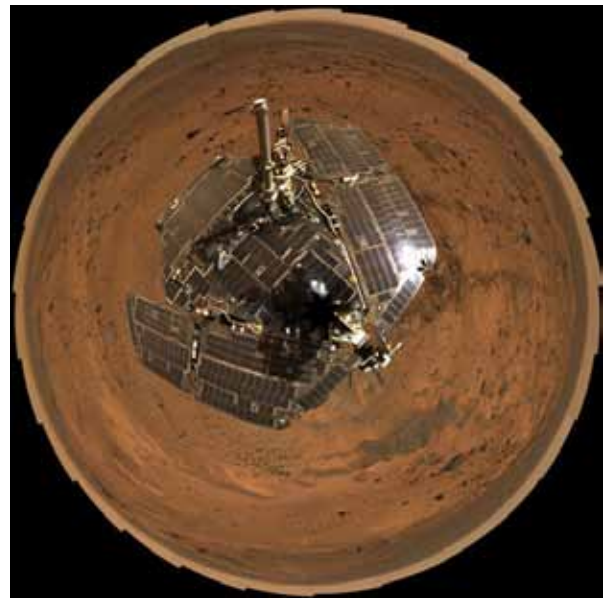
"Spirit's unexpected discovery of concentrated silica deposits was one of the most important findings by either rover," said Steve Squyres of Cornell University, principal investigator for the Mars Exploration Rovers. "It showed that there were once hot springs or steam vents at the Spirit site, which could have provided favorable conditions for microbial life."

After surviving a massive dust storm, in 2009 Spirit became bogged down in loose sand that the mission team likened to a golfer's worst nightmare. To compound matters, the rover lost use of a second of its six wheels. Early in 2010, after efforts to free Spirit were unsuccessful, mission managers announced the rover would be repurposed as a stationary science outpost. But with the advent of Martian winter, electricity generated by Spirit's solar panels dipped; by late March 2010, the rover stopped transmitting.

"Our job was to wear these rovers out exploring, to leave no unutilized capability on the surface of Mars, and for Spirit, we have done that," said Mars Exploration Rover Project Manager John Callas of JPL.

The announced end to Spirit's mission triggered substantial coverage in external news media. Like the mission team and the general public, journalists anthropomorphized Spirit, calling it "the hard-working, nothing-comes-easy rover" of the mission's two robots, compared with its more easy-living twin. Half a planet away, the Opportunity rover continued a four-year trek from Victoria Crater, an 800-meter-diameter (half-mile-wide) bowl it investigated for two years, to the much larger Endeavour Crater.

In addition to memorials in news reports and on op-ed pages, Spirit garnered attention on the floor of the U.S. House of Representatives when Rep. David Dreier read a statement congratulating JPL on the "tremendous success" of the mission.



This bird's-eye view combines a self-portrait of Spirit's spacecraft deck and a panoramic mosaic of the Martian surface. Spirit captured this 360-degree panorama on the summit of "Husband Hill" inside Mars' Gusev Crater in August 2005.

‘Eyes’ wide open for discovery

By Franklin O’Donnell

Interactive website offers virtual tour of planets and missions

It’s May 25, 2008, and you’re parked a few thousand miles above Mars. As the Phoenix lander comes screaming into the atmosphere, several orbiters converge on the planet’s north pole to witness Phoenix’s descent. With a few clicks you hop from craft to craft to inspect them more closely.

In the real world, such feats would depend on countless tons of fuel and painstaking engineering. But exploring the planets can be nearly effortless, thanks to a new interactive JPL website.

“Eyes on the Solar System” is a newly launched interactive website produced by JPL that lets users travel anywhere in the solar system anytime between 1950 and 2050. As they go, users can turn and zoom in or out at will and run the clock faster or slower (or backwards) to get a close view of planets and missions.

High on realism, “Eyes” uses detailed imagery of planetary surfaces and renderings of spacecraft to make the experience as lifelike as possible. In addition to the planets and moons, the system includes Pluto and four other dwarf planets as well as 15 asteroids and a handful of comets.

“Essentially it’s a virtual camera that you can take anywhere in the solar system across a century,” says Kevin Hussey, manager of the Visualization Technology Applications and Development Group that created “Eyes.” The site is online at *solarsystem.nasa.gov/eyes*.

Hussey and his team spent a year developing the package before releasing it in beta late in 2010. In addition to fixing bugs, they continue to add new features such as data on more missions and more space objects. Besides Hussey, the team includes technical consultant Doug Ellison, three software developers—Viet Nguyen, Paul Doronila and Anton Kulikov—as well as 3-D artist Brian Kumanchik and intern Christian Lopez.

One thing they quickly found is that the site is so powerful that some users didn’t know what to do with it. “We had to turn stuff off—it was too complex,” said Ellison. They also added more tutorials, tours and pre-scripted flyby experiences to showcase the site’s capabilities. But “third, fourth and fifth graders get ahold of it and use it like a pro in five minutes,” Ellison added. “They’re not afraid to try things and explore.”

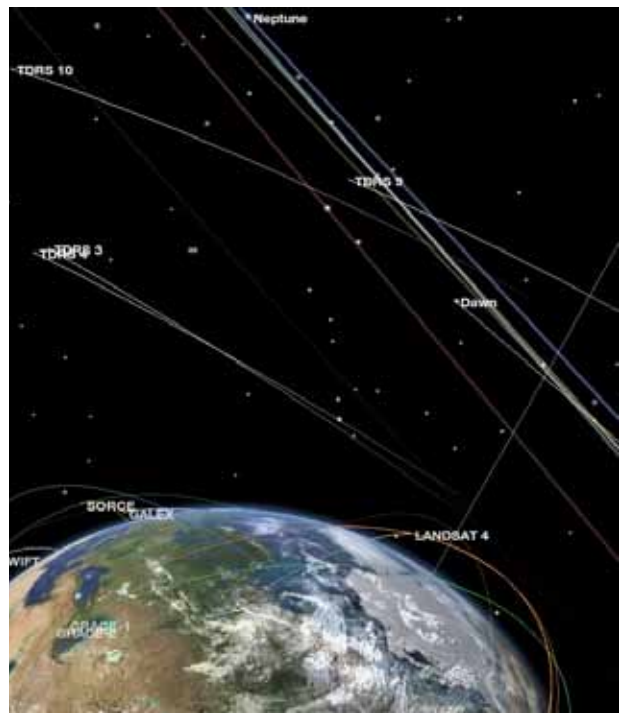
“Eyes” is the latest product in a long career in visualization for Hussey, who led the creation of one of the first data flyover videos, “L.A. The Movie,” at JPL in the mid 1980s. Hussey left the lab in the 1990s to spend eight years at Disney Feature Animation, then came back to JPL in 2003.

One of his first projects after returning was to produce visualizations for Cassini’s orbit insertion at Saturn with Richard Weidner. Two years ago, he and his team created a website called “Eyes on the Earth,” which allows users to access near-real-time data from NASA’s Earth orbiting satellites.

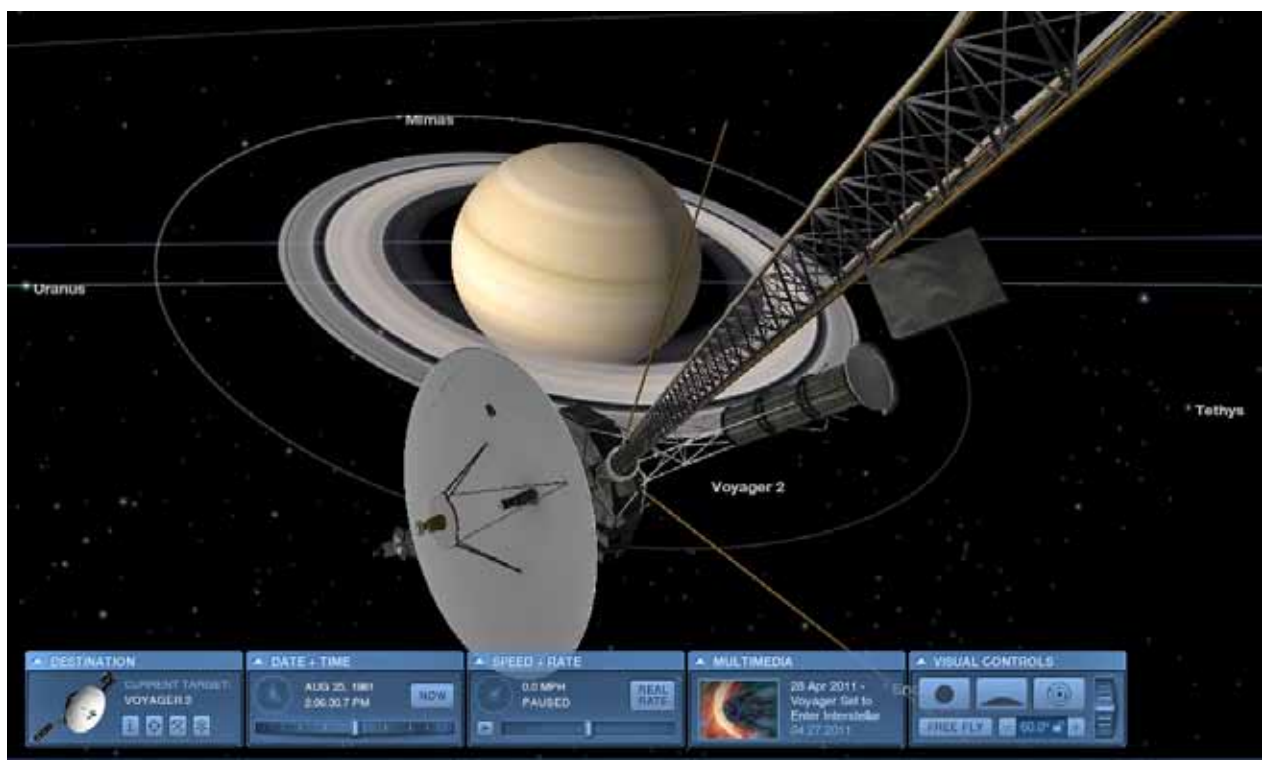
“Technology keeps moving,” said Hussey. “In the 1980s, visualizations required huge computers. When I look at what we did in 2004, it now looks pedestrian. Today’s personal computers are much more powerful than what was available even a few years ago.” “Eyes on the Solar System,” he said, is “a lot of NASA/JPL data put inside a game engine inside a web browser.”

The team is in the process of reworking “Eyes on the Earth” to take advantage of the infrastructure they created for “Eyes on the Solar System.” They also plan to add features such as the ability to share content on social networks.

As their next major project, the team is looking beyond the solar system to the rapidly expanding realm of planets orbiting other stars. Before long, don’t be surprised to see “Eyes on the Galaxy.”



Top: The Galileo orbiter passes close to Jupiter’s moon Europa during its eight years investigating the giant planet. Above: A small portion of the fleet of satellites keeping an eye on our home planet, Earth.



Right: Riding along with the Voyager 2 spacecraft during its flyby of Saturn in 1981.

News Briefs

Bruce Banerdt

Amy Mainzer

Mars interior to be studied in Discovery proposal selection

NASA's Discovery Program announced that JPL has been selected to pursue preliminary design of a mission that would study the structure and composition of the interior of Mars, one of three science investigations from which NASA will pick one potential 2016 mission.

The Laboratory was also named to lead a new technology-development proposal.

Bruce Banerdt, project scientist for the Mars Exploration Rovers, is principal investigator for the Geophysical Monitoring Station, which would study the structure and composition of Mars' interior and advance understanding of the formation and evolution of terrestrial planets. JPL would manage the project if it's selected.

The proposed Mars lander would carry three experiments: A seismometer for measuring Mars quakes; a thermal probe that beneath the surface would monitor heat flow from the planet's interior; and radio capability for Doppler tracking of tiny variations in the planet's wobble that would provide information about the size and nature of the core.

The other two selected for preliminary design studies are the Titan Mare Explorer, which would land in and float on a large methane-ethane sea on Saturn's moon Titan (Applied Physics Laboratory would manage the project); and Comet Hopper, which would land on a comet multiple times and observe its changes as it interacts with the sun. Goddard Space Flight Center would manage.

Each investigation team will receive $3 million for its mission's concept phase or preliminary design studies and analyses. After another detailed review in 2012 of the concept studies, NASA will select one to continue development efforts leading up to launch. The selected mission will be cost-capped at $425 million, not including launch-vehicle funding.

Three technology developments for possible future planetary missions also were selected. Amy Mainzer of JPL is principal investigator for NEOCam, which would develop a telescope to study the origin and evolution of near-Earth objects and study the present risk of Earth impact. It would generate a catalog of objects and accurate infrared measurements to provide a better understanding of small bodies that cross Earth's orbit.

The other two selected technology developments are the Primitive Material Explorer, which would develop a mass spectrometer to measure the chemical composition of a comet and explore the objects' role in delivering volatiles to Earth (Anita Cochran of the University of Texas is principal investigator); and Whipple, which would develop and validate a technique called blind occultation that could lead to the discovery of celestial objects in the outer solar system. The Smithsonian Astrophysical Observatory is principal investigator.

For more information about the Discovery Program, visit *http://discovery.nasa.gov.*

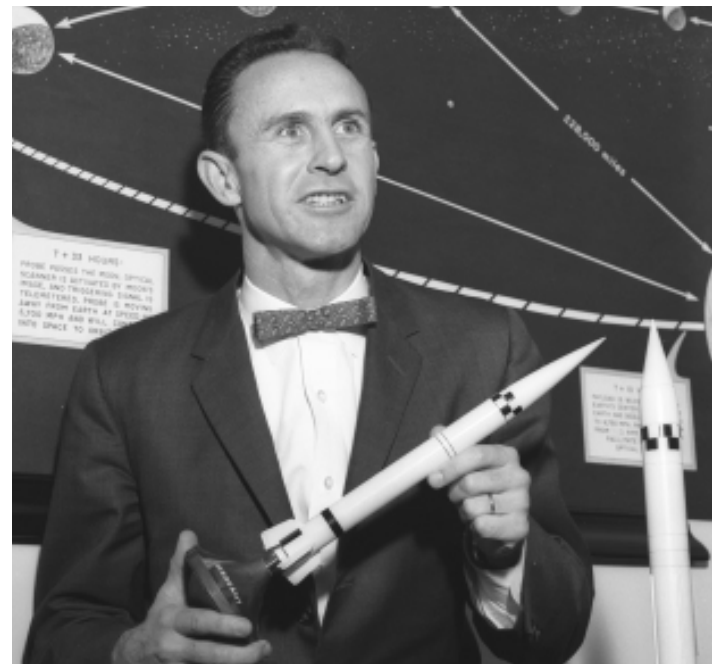
Kevin Hand

National Geographic honors researcher Hand

JPL astrobiologist Kevin Hand has been named to National Geographic's 2011 class of Emerging Explorers, which recognizes adventurers, scientists, photographers and storytellers who push the boundaries of discovery, adventure and global problem-solving while still early in their careers.

Hand, who works in the Planetary Ices Group, is one of 14 visionary young trailblazers honored this year by the society. The honorees each receive an award of $10,000 to assist with their research.

See Hand's profile at *http://www.nationalgeographic.com/field/explorers/kevin-hand.*



JPL PHOTO LAB

Bob Parks with a Sergeant model, 1959.

Early planetary leader Parks dies

Robert Parks, the early leader of JPL's planetary program who went on to serve as the Laboratory's deputy director, died Friday, June 3. He was 89.

Joining JPL in 1947, Parks was responsible for many flight projects including Mariner 2, the 1962 Venus mission that was the first successful flyby of another planet; Rangers 7, 8 and 9, which produced the first closeup photos of Earth's moon; the Mariner 4 mission that photographed Mars in 1965; and the Surveyor lunar soft lander series in 1966–68.

He also led activities for Mariner 5 to Venus in 1967, Mars 6 and 7 to Mars in 1969, Mariner 9 to Mars in 1971, Mariner 10 to Venus and Mercury in 1973, JPL's Viking orbiters in 1975, and was especially proud of his contribution to 1977's Voyagers 1 and 2 to the outer planets.

Parks later served as associate director for space science and exploration and as assistant laboratory director for flight projects before becoming JPL's deputy director in 1984. He retired in 1987.

Born in Los Angeles in 1922, Parks graduated with honors from Caltech in 1944 with a bachelor's degree in electrical engineering. From 1944 to 1946 he served in the U.S. Army Signal Corps, meeting his wife, Hanne, when he was stationed in Vienna. Parks worked briefly for Hughes Aircraft Co. in Culver City before joining JPL.

In addition to his widow, Parks is survived by his son Gary, a JPL employee who has served as project manager on Herschel/Planck and spacecraft manager for the Mars Phoenix Lander, and who is currently an element manager on the Advanced Mirror Development project; son John, of Costa Mesa; and grandsons Sean, Colton and Wesley. Parks had another son, Rick, who predeceased him.

A celebration of his life will take place on Saturday, June 18 at the residence of John Parks in Costa Mesa. Those interested in attending can send an RSVP e-mail to Gary Parks.

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Passings

Dave Curkendall

David Curkendall, 74, a retired manager who led a major project that evolved into modern-day parallel supercomputers, died May 11.

Curkendall joined JPL in 1961. He later became manager of the Navigation Group, responsible for researching, determining and implementing deep-space navigation techniques. He briefly left JPL to found Action Computer Enterprises in Pasadena, which developed, manufactured and marketed a series of mini-computers with the first application of multi-processing. He returned to the Lab in 1984 to lead the Caltech/JPL Hypercube Project, the development of massively parallel multi-processing computers.

Curkendall also managed JPL's High Performance Information Technology Office and led the Lab's Advanced Laboratory for Parallel High-Performance Applications. He retired in 2004.

Curkendall is survived by his wife, Dotti; sons Eric and Jay; and grandchildren Doni, Ramses and Ivan. Curkendall's family requests consideration of donations in his memory to the Altadena Library. A memorial service and celebration of his life will be held June 25 at the family home in Altadena. Details are pending. Contact Stephanie Chong at ext. 4-4888.

Letters

My wife and I would like to thank our friends and colleagues in IND, DSN and ITT for their kind and thoughtful condolences following the death of my sister, Judy Keith. The flowers, plants, cards, and letters were greatly appreciated and comforting.

Wayne Sible and Joan Petersilge

I would like to thank all of our friends at JPL for their condolences at the loss of my father, Dr. Horst Liepack. The support I received here helps me a lot to go through this difficult time.

Oti Liepack and family

My family and I wish to thank friends and colleagues at JPL and on the Juno project for your expressions of sympathy in the sorrowful departure of my younger sister. Your flowers, cards and heartfelt words of sympathy are sincerely appreciated.

Wafa Aldiwan

On behalf of myself and my family, I would like to extend a heartfelt "thank you" to all my JPL friends and coworkers for your thoughts and prayers upon first learning of my brother's illness, and for your continued prayers and condolences upon his passing. The outpouring of love has been very comforting during such a difficult time in my life. The plants and fruit basket were beautiful and very much appreciated.

Roberta Martin

We would like to thank our friends and colleagues for the support and condolences we received after the recent passing of our father. Thanks to all of you who attended the services. Our family was quite touched by the large JPL presence at the services. Sincerely,

Scott and Steve Flores

Retirees

The following JPL employees retired in May: **Nancy Grenander,** 27 years, Section 314C; **Ron Holm**, 24 years, Section 383J; **Pamela Ray**, 22 years, Section 172C; **Patricia Hallack,** 13 years, Section 3818; **David Flores,** 10 years, Section 2151.