Discovery Dispatch

A Quarterly Newsletter of the NASA Discovery Program

January 2001
Volume 2 Number 1

A Note from the Discovery Program Manager

The Near Earth Asteroid Rendezvous mission is drawing to a close. The first mission to launch in NASA's Discovery Program, the NEAR Shoemaker spacecraft has provided a fantastic window on the asteroid Eros. As the first mission to conduct a long-term, close-up study of an asteroid, NEAR Shoemaker has collected information on Eros' mass, structure, geology, composition, gravity and magnetic field that will keep scientists busy analyzing data for many years to come.

We thought it would be a good time to look back at the history of the NEAR mission and the Discovery Program, as the two are very closely linked. To get the human perspective we interviewed three individuals who greatly contributed to the remarkable success of the mission: Project Scientist Andy Cheng, who covers some of the science results to date; Mission Director Bob Farquhar, the colorful, self-described curmudgeon whose wizardry with trajectories and faith in lucky numbers set him apart even in a world of quirky scientists; and Project Manager Tom Coughlin, whose superb leadership since the beginning made NEAR a special project for all who participated.

Congratulations to Tom Coughlin and the entire NEAR Shoemaker team for a job well done.

Dave Jarrett

Inside

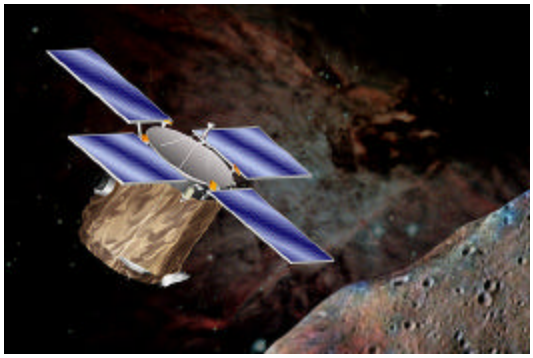
Discovery Home Page

http://discovery.nasa.gov

NEAR End of Mission Approaches

A controlled descent to the surface of Eros on February 12, 2001, will bring to an end the orbit phase of the NEAR mission. Since its launch almost 5 years ago, NEAR has accomplished many "firsts" in space exploration:

- First launch in the Discovery Program
- First spacecraft to orbit a small body
- First in-depth exploration of a near-Earth asteroid (Eros)
- First reconnaissance of a C-class asteroid (Mathilde)
- First planetary mission launch for the Delta rocket
- First spacecraft powered by solar cells to fly beyond the orbit of Mars



The NEAR mission aims to answer fundamental questions about the nature and origin of the many asteroids and comets close to Earth's orbit.

This issue of the Discovery Dispatch is both a retrospective view of NEAR and a tribute to the mission and science team members at The Johns Hopkins University Applied Physics Laboratory and other institutions across the country, the navigation team at the Jet Propulsion Laboratory, and the management team at NASA who made it all happen.

A Look Back at the Beginning:
How the Discovery Program and the NEAR Mission Came to Be

The Earliest Notions

In 1989, NASA's Solar System Exploration Division (SSED) initiated a series of workshops to define a new strategy for exploration through the year 2000. The panels included a Small Mission Program Group (SMPG) that was chartered to devise a rationale for missions that would be low cost and allow focused scientific questions to be addressed in a relatively short time. Their second meeting resulted in a recommendation that small spacecraft should be used to implement limited-scope missions. This was quite different from NASA's norm of conducting very large missions carrying many instruments, taking many years to get organized and often costing more than one billion dollars.

The proposal was greeted with widespread skepticism. NASA had already attempted to implement a low cost Planetary Observer program beginning with Mars Observer, which grossly overran its budget and schedule. One SMPG

continued on page 2

member who was involved with NASA's Explorer program pointed out to workshop participants that Explorer should be the model for small, focused, low cost missions, not Planetary Observer. Explorer had provided relatively easy access to space for the space physics community since the late 1950's. After more thorough briefings on the Explorer concept to the plenary, participants were persuaded this was indeed a good model and asked the SSED to study this approach for inclusion in their long range plan.

A number of things began to happen. A fast-paced study for a potential mission was requested and funding arrangements were made. A Science Working Group was established to further define the low cost concept. This group met in late 1989 and again in May 1990, and reviewed a number of concepts that could be implemented as low-cost programs. They proposed that the new program be called Discovery.

Later in 1990, the SSED Director, Dr. Wesley Huntress, asked the working group to focus on a specific mission and evaluate studies from both The Johns Hopkins University Applied Physics Laboratory (JHU/APL) and the Jet Propulsion Laboratory (JPL) on the feasibility of the Discovery approach. The group quickly converged on the Near Earth Asteroid Rendezvous (NEAR) mission that NASA had previously looked at as a possible Planetary Observer mission (in fact, since the end of the Apollo missions of the 1970's, planetary scientists such as Gene Shoemaker had felt the next logical step was to explore an asteroid, the nearest neighbor to Earth).

Ideas Become Reality

The JHU/APL and JPL studies were completed in May 1991, and their presentations to the Science Working Group revealed different findings. JHU/APL concluded such a mission was doable for approximately $110 million, while JPL suggested it was improbable to carry out the first Discovery mission for less than $150 million. The Science Working Group and other senior NASA managers found the JHU/APL approach to be preferable and made this recommendation to the SSED Director. Dr. Huntress decided to include the Discovery Program as an element in the 1991 SSED Strategic Plan, with NEAR as the first mission to be implemented.

Meanwhile at the Capitol, the FY-1992 appropriations bill passed by Congress in the fall of 1991 directed NASA to prepare "a plan to stimulate and develop small planetary or other space science projects, emphasizing those which could be accomplished by the academic or research communities." NASA prepared the requested report and submitted it to Congress in April 1992, but due to a variety of programmatic considerations, named JPL's MESUR-Pathfinder mission to Mars as the first Discovery mission, with NEAR as the second.

NEAR is a Go

In the fall of 1992, Bob Farquhar at JHU/APL identified an exciting opportunity to send the NEAR spacecraft to asteroid 433 Eros, the largest near-Earth asteroid, with a launch in February 1996. NASA proposed in its FY-1994 budget request to Congress that both MESUR-Pathfinder and NEAR be initiated as new starts that year, and Congress concurred. The funding for NEAR arrived at JHU/APL in December 1993, and the spacecraft was shipped to the Kennedy Space Center 24 months later.

The launching of NEAR aboard a Delta rocket.

On February 17, 1996, NEAR became the first mission to launch in the Discovery Program. It exceeded all three principal requirements for Discovery: its cost of $112 million was well within the $150 million cost cap; the 27 month duration from development to launch surpassed the 36 month development cap; launch was from a Delta rocket, as required.

For some perspective on the significance of a mission to orbit an asteroid, it should be noted that previously the best data available on asteroids came from two Galileo flybys: one in October 1991 of 951 Gaspra, the first ever flyby of an asteroid, and the second less than two years later, of 243 Ida. Because it would spend a full year in orbit around Eros, NEAR's science objectives were quite ambitious. The mission would provide answers to many fundamental questions about the nature and origin of asteroids and comets.

The Glitch

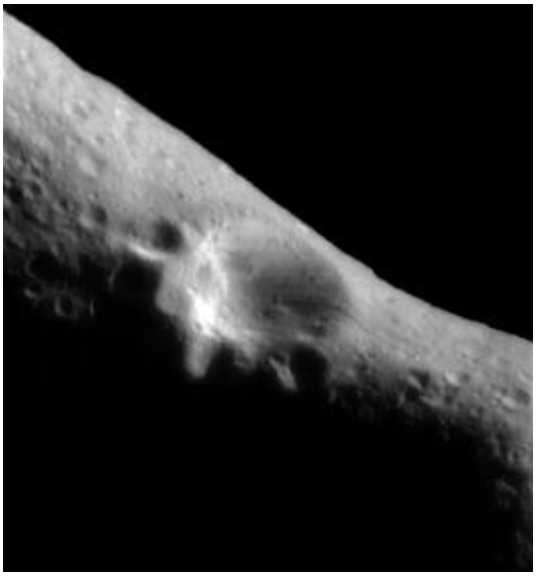
After a flyby of asteroid Mathilde in June 1997 that provided the first close-up images of a C-class asteroid, NEAR was on its way to a February 1999 rendezvous

continued on page 3

with Eros. On December 20, 1998, as the spacecraft performed a main engine burn intended to slow it down for its impending orbit insertion, contact with NEAR was lost. After an agonizing 27 hours of silence, NEAR's radio was finally heard at mission control. The spacecraft had tumbled out of control, for reasons that have never been completely determined, and now, speeding past Eros at about 2,000 mph, it might be able to snap a few images but had no chance of slowing enough to keep its planned encounter date. However, because Mission Director Bob Farquhar had insisted that his team draw up contingency plans, they pored over the possibilities and chose one that would place NEAR back on the road again for a year, meeting up with Eros, named for the Greek god of love, on Valentine's Day, 2000.

The Rewards

On February 14, 2000, NEAR began its year-long orbit of asteroid Eros to determine its mass, structure, geology, composition, gravity, and magnetic field. NEAR's six science experiments contribute in different ways to understanding Eros: a magnetometer determines whether Eros has a magnetic field; the X-ray/gamma-ray spectrometer measures key elements; the near-infrared spectrometer maps mineral composition; the laser rangefinder reads the shape of the asteroid; a radio science experiment determines mass and density; and a multispectral imager studies asteroid rock types and geology.



NEAR's historic first image from Eros orbit. The two smaller craters superimposed on its rim are each about 1.2 miles (2 kilometers) across. An enormous boulder a full 170 feet (50 meters) in size sits on the large crater's floor.

On March 14, 2000, during the 31st Lunar and Planetary Science Conference in Houston, the NEAR spacecraft was renamed NEAR Shoemaker to honor Dr. Eugene M. Shoemaker, the legendary geologist who influenced decades of research on the role of asteroids and comets in shaping the planets.

Preliminary Results

Previously scientists theorized that asteroids were either solid iron or cosmic rubble piles—Eros is neither. Data suggests that Eros is a fractured chip off a larger body, made of some of the most primitive materials in the solar system. Its uniform density (about the same as Earth's crust) and numerous grooves and ridges imply it is a cracked but solid rock, not a gravity-bound collection of rubble. The cratered surface has steep cliffs and is covered by a deep layer of moving regolith, the loose rocks and dust left over from collisions with other objects.

NEAR Shoemaker captured this amazing picture of adjacent regions in different states of surface degradation on January 7, 2001, from an orbital altitude of 35 kilometers (22 miles). The upper half and lower right parts of the image show surfaces with "typical" rounded craters and large boulders. However, the abruptly edged swath extending from lower left to middle right is remarkably more smooth, subdued, and lacking in small-scale detail of any type -- almost as if Eros had been altered by a giant eraser. The whole scene is about 1.4 kilometers (0.9 miles) across.

Combining digital images, Doppler tracking and data from the laser rangefinder, scientists have built the first detailed map and three-dimensional model of an asteroid. The regolith on Eros is nearly 300 feet deep in places, and its uneven distritution affects the asteroid's gravity. Further data indicate the regolith moved on the bumpy surface, smoothing over rough areas and spilling into craters.

The craters themselves have raised many questions, especially the square ones. More than 100,000 craters wider than 50 feet have been counted, along with about

continued on page 4

one million house-sized or larger boulders. To keep track of the asteroid's main features, team members have proposed nearly 40 names (based on romantic figures in history and literature, in keeping with the god of love/Valentine's Day theme) which are pending approval by the International Astronomical Union.

A Look Ahead

This month, NEAR Shoemaker begins a series of low-altitude passes over Eros in a prelude to its upcoming descent to the surface. The mission wraps up February 12 with NEAR Shoemaker's controlled descent to Eros, a tricky maneuver that will allow the craft's digital camera to snap close-ups of the asteroid's cratered, boulder-strewn landscape. The spacecraft is nearly out of fuel, and by the end of January it will have completed its scientific objectives at Eros. While the maneuvers are risky, the hope is to end the mission getting a lot of bonus science - with images better than any taken before. The flyovers will provide a detailed look at the surface, much like the view when the spacecraft came within 3 miles of Eros during the low flyover in October, but over different areas this time, to find out if the small-scale geological features seen in the earlier images are typical of the surface.

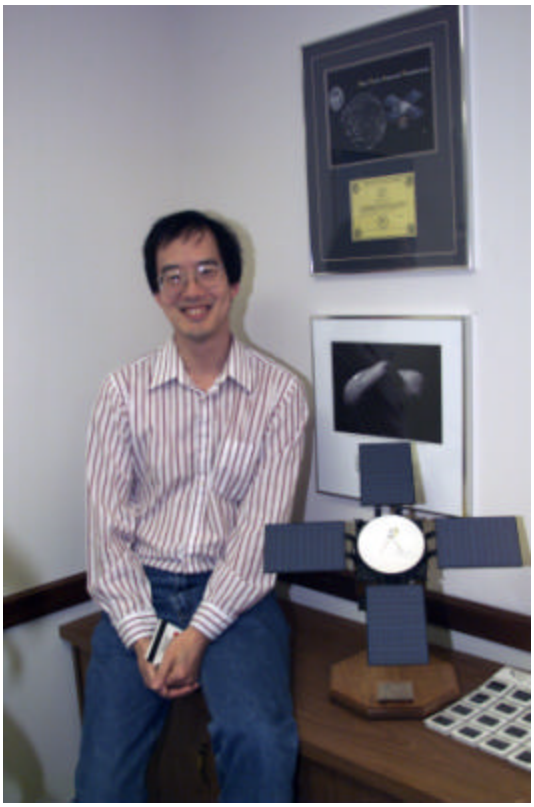
Epilogue

It's been a long and winding road since scientists first envisioned a mission to an asteroid. The earliest serious proposal by Friedlander and Vickers in 1964 envisioned a rendezvous mission to asteroid Eros! NEAR has succeeded in returning an incredible amount of data that will prove vital for future missions -- possible landers, sample returns, or even human expeditions. NEAR's data should also provide critical information on Earth crossing asteroids to help scientists figure out how to deflect or destroy one that may be heading for Earth. The analysis of data will continue for a long time to come.

NEAR Project Scientist Andrew Cheng

Andy Cheng grew up in New Jersey, attended Princeton University, majoring in physics, then did his graduate studies at Columbia University. He worked in astrophysics at Bell Labs, then joined the faculty of the physics department at Rutgers University. His primary research interest was pulsars when he began working with Tom Krimigis of APL in the late 1970's on the Voyager mission as it was heading to Jupiter. It was his first involvement with planetary science. He joined APL in 1983 and worked on Voyager during its Saturn, Uranus and Neptune encounters, and then got involved with Galileo where today he is an interdisciplinary scientist investigating magnetospheric physics at Jupiter. He is also a Cassini co-investigator, serving as a member of the Magnetospheric Imaging team on the mission to Saturn and Titan.

Andy first heard discussions about exploring asteroids in the mid-1980's. He thought it was a good idea, that it could answer fundamental questions about the beginning of the solar system.



NEAR Project Scientist Andrew Cheng

He was the study scientist in 1990 when APL was asked to submit a concept study on a near Earth asteroid mission and became project scientist when NASA awarded the mission to APL. He is responsible for the overall integrity of science returns from the NEAR mission and is the lead for science data analysis and archiving, science planning, and conflict resolution among NEAR science requirements.

Thoughts on the NEAR Experience

Soon after NEAR went into orbit around Eros, Andy said, "Work is just starting, but it's already clear that Eros is much more exciting and geologically diverse than we had expected." Now that it's ending, he feels it was a success beyond his wildest hopes. Andy has done a great job of sharing the news and excitement of NEAR with the public through his regular science updates on the NEAR website (http://near.jhuapl.edu/news/index.html#sci_up). They reflect the whole complex of emotions he has experienced throughout the past year. As it comes to a close, what has the mission meant to him? "Certainly it's been a defining moment. Many people experience a time when they're most intense in their life, and my

continued on page 5

feeling is the past 10 years have been that part of my life. Like being in the front in a war—that's how I feel about NEAR. I'm very fortunate to have been able to experience something like that. I don't know if I'll ever have anything like that again."

Andy's greatest satisfaction is the fact that the mission actually worked. "We are bringing back a wonderful treasure of information," he says, "We've barely begun to mine it. We showed it is possible to do a low cost planetary mission and have it be a scientific success, not just an engineering success. People often claim success on the basis of just technical achievements, which is fine, but what I'm happy about is this mission has also been a success from a scientific view. It puts it in the same category as the missions we remember so fondly, Voyager for example."

NEAR's Science Results

What will the results will mean to the scientific world? "We are in fact opening up a whole category of new worlds," he says. "I think we're beginning to realize that the nine planets are only part of the story, that the small bodies in the solar system have a lot to teach us also. I think it's just the beginning of a whole new aspect of planetary exploration. There are many different types of small bodies out there. There is as much different physics among the asteroids and comets as there is in all the planets. There's as much geologic diversity. Not paying attention to asteroids and comets is like reading a book in which you've ripped out half the chapters. They are really a big part of the story of what the solar system is and how it came to be. I think that's becoming increasingly recognized and NEAR was the first step. There's going to be a lot more."

The NEAR science team had a lot of expectations and have had a number of surprises. According to Andy, "Some predictions were correct, some weren't. For example most people were leaning toward the view that Eros is somehow related to ordinary chondrites. That's been confirmed. On the other hand, some aspects of the elemental composition don't quite fit in, and we're not sure what that means. Depletion of the sulfur is very intriguing. It may mean that in reality Eros is not ordinary chondrite material after all, but is something that is very rare on Earth.

"Another thing that surprised everyone was the cratering. It's totally different from what you see on the Moon. Craters get extremely small on the Moon -- that didn't happen on Eros. Some geologic process we don't understand is happening which causes there to be many fewer craters under 100 meters than we would predict. The other thing that's very strange, that we don't yet understand, is the large number of what look like rocks sitting on the surface. There's huge numbers of them, far more than expected, more than craters. There are indications that the surface may actually be saturated with boulders. That's a very intriguing result indeed, how the surface got that way. The nature of the regolith of Eros is not something we expected. It does not look like the Moon at all in terms of size and physical properties."

Future Challenges

The next challenge is to make sure there is money to analyze the NEAR data. "I'm working on that," Andy says. "There's an intention to start a NEAR data analysis program, which first involves writing a lot of proposals. We are looking forward to the opportunity to analyze the data and participate in the exploration which actually continues even after the end of the flight operations, because we now have a chance to think about what the data actually means. We haven't had much chance to do that so far."

Andy is also a member of the science teams for CONTOUR and MESSENGER (APL's next Discovery missions, scheduled to launch in 2002 and 2004). "I'm not a project scientist or anything like that, " he says, "so I can participate in the science and not have to worry about all the mission things." Does he have any advice for new Principal Investigators, or those planning to propose a mission? "They should know what they're in for," he says, "It's a big commitment. It's fun, but it will take you away from science. Be sure that's what you want to do."

NEAR Mission Director Robert Farquhar

Much has been written about Bob Farquhar—he's unique in the world of engineers and scientists. He can be a free wheeling rebel, but, like a good boy scout, he fully understands the need to always be prepared with backup plans. He's been called sentimental because he designs key events to coincide with birthdays and anniversaries of family and friends, but his practical, inventive trajectories allow spacecraft to go where they otherwise couldn't go, at low cost using minimal fuel. He enjoys the competition of space exploration—he likes being first, but admits to being a poor winner because he likes to rub it in.

If you're going to brag, you'd better be good - and Bob Farquhar is good. He's a recognized expert in the areas of orbital mechanics, mission design, and overall systems design of low-cost space missions. His forte is designing cost effective missions with an

continued on page 6

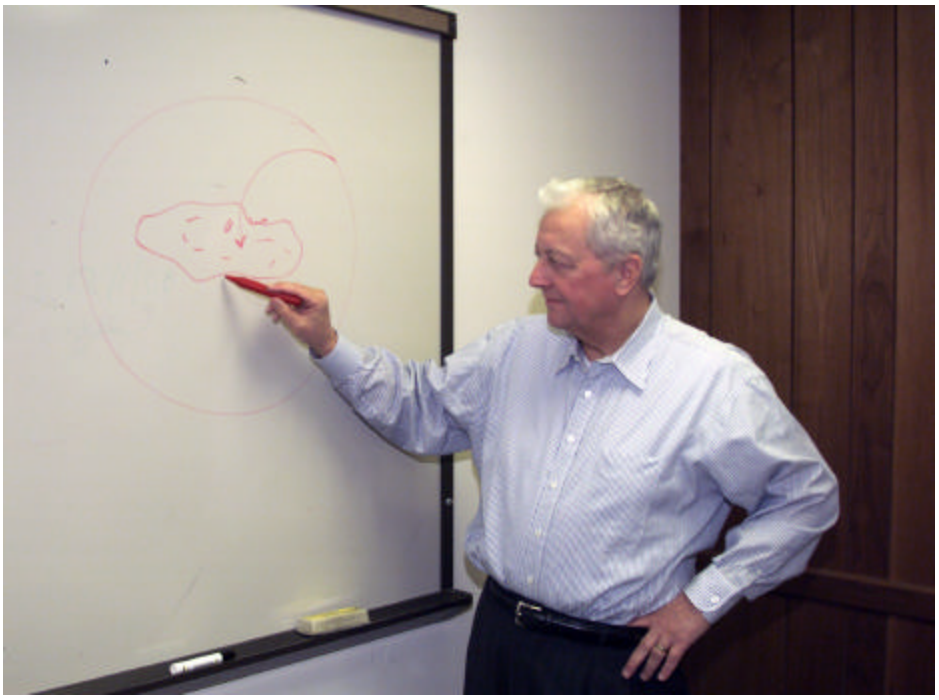
artistic creativity. A longtime colleague calls him a genius at celestial pinball.

Bob grew up in Chicago, found himself bored in school and graduated in the bottom 40% of his high school class. But on his own time he built a radio controlled World War I bomber, drawing up all the plans himself. He joined the military and became a paratrooper, then enrolled at the University of Illinois at Chicago, where he discovered in a celestial mechanics class that he was good at calculating orbits. He went on to earn his PhD in Astronautical Sciences and to graduate with honors.

Bob Gets Into the Space Business

Bob's first NASA experience was a summer job at the Marshall Space Flight Center in 1960, working on the first stage of the Saturn V rocket. Later, while at NASA's Goddard Space Flight Center, he was the Flight Director for the International Sun-Earth Explorer 3 mission to study solar wind. But Bob put another twist on the mission when he altered the trajectory, using his innovative "halo orbit," to send it through the tail of Comet Giacobini-Zimmer six months before other nations got to Comet Halley. That spacecraft, renamed International Comet Explorer, is due to flyby Earth again in 2014 and Bob plans to be there to greet it.

Bob retired from NASA in 1990, about the time JHU/APL was looking to get into the world of solar system exploration. When APL was awarded the NEAR mission, Bob was recruited as a mission architect. He says his greatest satisfaction from NEAR is that it's all gone according to plan. And he really liked the Mathilde flyby. "It's the most difficult flyby encounter that's happened," he says, "mainly because we came in from such a terrible phase angle. It was a target of opportunity. We could barely do it, but we did and it came off perfectly." He's also happy with the science results, and his competitive pride comes through when he notes that NEAR has taken the second highest number of images and the highest density of images for a body so small.



NEAR Mission Director Robert Farquhar sketches the asteroid 433 Eros.

Bob's practical nature helped save the day on December 20, 1998, when contact with NEAR was lost and the spacecraft tumbled out of control. "Being prepared with contingency plans is one of the things I insist on and everybody makes fun of it," Bob says, "until this time with the NEAR mission, they didn't make fun of it. It's a lot of extra work—you spend more time working on the contingency plan than on the baseline plan. But we were also lucky, we almost lost the spacecraft because we lost almost 30 kg of hydrazine fuel. If we'd lost another 10-15 kg we couldn't have done anything. It would have been all over. So a combination of luck and pre-planning saved it."

What's his advice for aspiring mission designers? "Students should take a lot of math and physics courses," he says, "that's the main thing, then they can specialize later. For mission design, celestial mechanics is essential. The most important thing is some knowledge of all the different fields—you have to know about scientific tradeoffs; you can't just go by what the scientist says. Most people in mission design wait for the scientist to give them the requirements, then they design to the requirements. You can do that but then you're not going to show up with any new concepts. You really have to understand what all the science goals are. Like a good systems engineer on a spacecraft has to understand all the subsystems, same thing with a mission designer—you have to understand the spacecraft design, the orbit, navigation, space science, in addition to program and political considerations. You can have a great idea but programmatically it may not work if NASA doesn't have the money or if another mission should precede it. You have to understand all this. It's very competitive. I love competition, especially if you win."

Bob says he'll be relieved when NEAR ends, that he's ready to move on to other things. He's committed to writing chapters in a number of books, and he's working on CONTOUR

continued on page 7

and MESSENGER, APL's next Discovery missions. He's already completed the trajectories for CONTOUR, a mission to study the diversity of comets. The baseline plan says it will fly by at least two comets, but Bob hopes to fly by 3, 4 or even 5.

Bob finds time for an unusual hobby, the postal history of Manchuria from 1925 to 1951. He loves the history and writes articles and attends auctions. He says he thinks he'd like to work in the White House for awhile, as Senior Advisor on Space Policy. He may pursue that with the new administration. He says, "I've got stuff to take me pretty much up to the end of my career, which I figure is around 2014 or 2012. Twelve is my lucky number."

NEAR Project Manager Thomas Coughlin

Thomas Coughlin is the programs manager for the Space Department at The Johns Hopkins University Applied Physics Laboratory. During 1990-1991 he served as proposal manager for the NEAR mission and became project manager when NEAR was awarded to APL in 1992.

Tom hasn't strayed far from home. He grew up in Baltimore, Maryland, and attended Drexel University in Philadelphia, where he earned a B.S. in Mechanical Engineering and an M.S. in Aerospace Engineering. He first went to work at Martin Marietta in Baltimore, then joined APL in 1972. He worked on a number of Strategic Defense Initiative programs and was awarded the Distinguished Public Service Medal, the highest award the Department of Defense gives to civilians.

NEAR Project Manager Thomas Coughlin

So Little Time, So Much to Do

Tom's involvement with NEAR started at the very beginning. He remembers that NEAR didn't have the luxury of a development phase; they hit the ground running and began implementation as soon as funding was received in December 1993. They had only 24 months to build the spacecraft and deliver it to Cape Canaveral, which they did in November 1995.

"APL had a long track record during the 1980's with the SDIO and we built a lot of spacecraft in less time than NEAR's development time," Tom remembers, "but those spacecraft were not as complicated. This was probably the most complicated we've ever done in that time period."

Tom recalls another unusual aspect of the NEAR mission—the way the scientists and their instruments came together. "Typically scientists develop their own instruments and bring them to us, but we had an unusual circumstance. We were told just the paperwork to procure instruments would take 9 months to a year, which our tight schedule would not accommodate. So we created what are called "facility class" instruments, which were based on looking at other government agency's previous projects and what they would take to a near Earth asteroid. We went out to industry, to Goddard, other academia and put together a suite of instruments in about a year.

"So when the scientists came on board in 1994 they already had instruments to work with. We all knew what we were up against was the schedule. They just worked wonders with the instruments, no complaints as I had feared. That was one of my biggest concerns, that the scientists would say, 'This doesn't work.' But it went beautifully, they just pitched in and we pulled together and everyone realized with the schedule we had this was the only way to do it. It was ever so rewarding. That was a high point for me, right up there with making the launch

continued on page 8

date and seeing the robust spacecraft up there working properly."

The Importance of Team Communication
An example of Tom's leadership style is the way he made sure the engineering team participated in science team meetings so they would understand the scientist's desires. "Evidently from the scientists I talked to," he says, "that hadn't happened before. 'Hey this is really neat,' they'd tell me, 'we didn't have that on other programs.'

During development there were four meetings per year where the whole group came together so the engineers could participate. Tom feels that's primarily how the camaraderie developed among the group. He also put an engineer on each instrument team so that the interface with the spacecraft was very well known. He recalls, "The integration went flawlessly."

About the NEAR team, Tom says, "They're dynamite, a great group. People like Andy Santo, the Spacecraft Team Leader, played such a key role. He was the technical lead during development. His title was System Engineer, it was the first time he held that position, and he did an excellent job. He did what Bob Farquhar does now. The team performed outstandingly. It was probably the most dedicated, motivated team I've ever worked with."

Tom has a concern that because there was a different team during development than those who are now operating the spacecraft, that very important people will be left out of the acclaim. He says, "Part of my job is to bring them back in to help make sure they can take a few bows now, while all the wonderful data is coming in. Once in a while we try to get the whole team back together to show what their contributions were that paid off so much today."

The Low Point
The low point of the NEAR mission was December 20, 1998, when communication with the spacecraft was lost for 27 hours as it tumbled out of control, for reasons that are still not fully understood. According to Tom, "We're big on peer review here and we had our own NEAR team look at it, but we couldn't figure it out. So we brought in a team with members from other departments at APL, JPL, and Goddard. They met for about 6-8 months and performed an extensive investigation and couldn't figure out what went wrong. You really want it to be solved but the fact that many people have looked at it and we haven't solved it, at least it wasn't an error of omission, something we just left out. There was some reward in that too."

As the End Draws Near
Have his expectations on the mission been fulfilled? "Very definitely. I don't come from a scientific background," Tom says, "but when I see Andy Cheng and the rest of our science team with smiles from ear to ear, it's real rewarding to me as the behind-the-scenes guy. It's one of the things you strive for, the relationship that we have with our science team. So many members of the science team and the JPL navigation team have come to me and said it's the best mission of their careers. That makes it all worthwhile."

Asked about his thoughts as the end of the mission approaches, when NEAR will no longer be up there gathering data, Tom reflects, "It's probably like when my son went off to college—I thought it would be a new life, a new honeymoon period for my wife and me, but all of a sudden you miss him. I'll probably go through something like that. No more NEAR. I can spend time doing my other job now
on programs, but I'm sure I won't be working as closely with friends and colleagues here. It will leave a hole. I doubt if I'll take on another project."

Tom Coughlin is one of the many reasons the NEAR mission has been so successful. He has not only technical expertise but, perhaps more importantly, he possesses the ability to motivate a team to do their best work.

Go to the NEAR home page at http://near.jhuapl.edu/ for complete mission information.

Discovery Dispatch

Written and edited by :
Shari Asplund
Discovery Program Outreach Manager

Layout and production by:
Andy Hernandez
Discovery Program Support Office Intern

Acknowledegements
The Journal of the Astronautical Sciences, Volume 43, Number 4, October-December 1995, was devoted to the NEAR mission. Much of the background information contained herein is from that publication.

Thank you to Mike Buckley of the APL Public Affairs Office for his assistance in preparing this newsletter.

National Aeronautics and Space Administration