Discovery Dispatch

A Quarterly Newsletter of the NASA Discovery Program

January 2002
Volume 3 Number 1

A Note From the Program Manager

We are very happy to welcome the two new Discovery missions, Dawn and Kepler, which were approved for continuation by the Office of Space Science in December. Congratulations to Dr. Christopher Russell of UCLA and Dr. William Borucki of NASA's Ames Research Center and their teams for their fine efforts so far. We look forward to working with these exciting new missions.

Bob Metzger, manager of the Discovery Program Support Office at JPL, is leaving Discovery to start up a costing office at the Laboratory. In this new position he will provide leadership, guidance, advocacy and service to the projects and technical organizations to improve the fidelity and consistency of JPL cost estimates. I want to acknowledge and thank Bob for the outstanding job he did in starting up the JPL Discovery Program Support Office in the spring of 1999 and the excellent work he has done in support of the projects. We will miss Bob, but we wish him well with his new challenge.

The CONTOUR spacecraft has left APL and moved to Goddard for environmental testing. It's an exciting and busy time for the mission, as the July launch date approaches.

In December, Genesis began its most important phase, as the collector arrays were extended and the capture of solar wind particles began.

This issue contains overviews of the two new missions and updates on the current status of the ongoing missions.

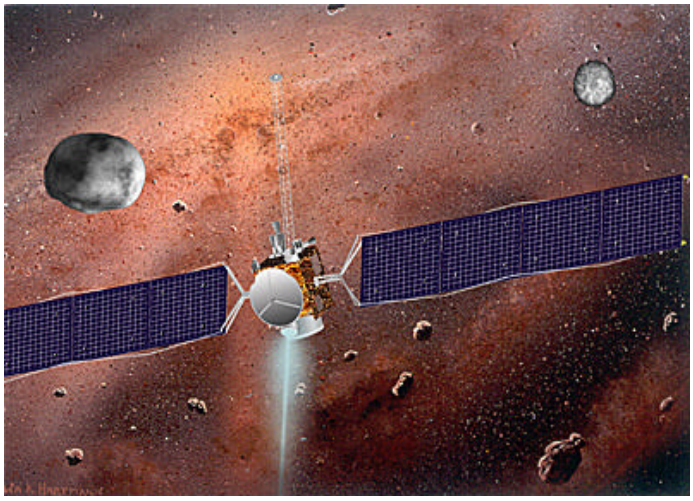
Dave Jarrett

Inside

Discovery Ushers In a New Dawn

The Dawn mission undertakes a journey in both space and time by traveling to the two oldest and most massive asteroids in our solar system, Vesta and Ceres. By observing both minor planets with the same set of instruments, Dawn will provide new answers to questions about the formation and evolution of the early solar system.

Dawn will be the first purely scientific mission to be powered by ion propulsion, an advanced technology successfully demonstrated by NASA's Deep Space 1 mission. It is the use of solar electric ion thrusters that will enable Dawn to orbit both asteroids in one mission, a feat that has not been attempted before.



Credit: William K. Hartmann, "A cocoon nebula, perhaps the primordial solar nebula."

Planned for launch in May 2006, Dawn will reach Vesta in 2010 and Ceres in 2014. These minor planets have remained intact since the earliest time of solar system formation. Their surfaces are believed to contain a snapshot of the conditions present in the solar system's first 10 million years. This is because their location in what we now call the asteroid belt was close enough to Jupiter as it was forming that its gravitational force disrupted their continuing formation (unlike Mars, Earth, Venus and Mercury which were far enough from Jupiter that they continued to change for 30-50 million years). Since Vesta and Ceres stopped evolving very early, the spacecraft will glimpse the conditions present before the development of the terrestrial planets, allowing Dawn

Discovery Home Page

http://discovery.nasa.gov

to investigate both the origin of the solar system and its present state.

The mission's science goals are to determine the asteroids' shape, size and mass; detailed elemental and mineral composition; tectonic and thermal evolution; internal structure and possible presence of magnetic fields and a metallic core. Scientists hope to gain a new understanding of the role of water in asteroid evolution.

Ceres and Vesta feature striking contrasts in composition. Scientists believe many of these differences stem from the conditions under which they developed, with Ceres forming wet and Vesta dry. Evidence of water -- frost or vapor on the surface, and possibly liquid water under the surface -- still exists on Ceres; this water may be the factor that kept Ceres cool throughout its evolution. At the same time, Vesta was hot, melted internally and became volcanic early in its development. As a result of these two different evolutionary paths, Ceres remains in its primordial state, while Vesta evolved and changed over millions of years. Together they form a bridge between the rocky bodies of the inner solar system and the icy bodies of the outer solar system.

Ceres, the largest asteroid in our solar system, is a roughly round object about 960 km (600 miles) in diameter. It orbits the sun in the asteroid belt between Mars and Jupiter approximately 400 million km (258 million miles) from Earth. Vesta is the brightest asteroid in our solar system as seen from Earth, and is the only one visible with the unaided eye; its oval, pumpkin-like shape has an average diameter of about 500 km (320 miles). Vesta is the second most massive minor planet. In comparison, the NEAR mission spent one year in orbit around asteroid Eros, which is only 35 km (21 miles) long.

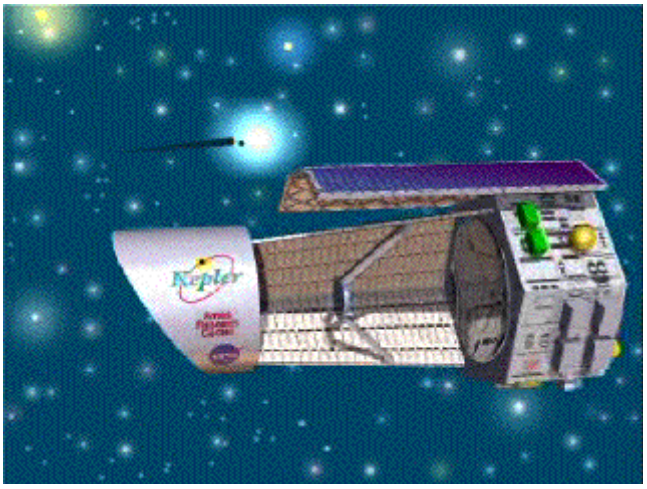
For more information on the mission, visit the Dawn website.

Kepler to Search for Terrestrial Planets

The Kepler mission is designed to find other Earth-like planets in orbit around stars in our galactic neighborhood. Kepler will search for extrasolar planets by watching for the periodic transit of planets across the faces of stars. A star displaying a transit dims slightly during the several hours it takes the planet to cross. This dimming, registered by the sensors of the Kepler photometer, will provide the raw data which ultimately will lead to the determination of the size and orbital period of the planet.

Only in the last few years have the technologies necessary to conduct such a search with low-risk and high reliability reached maturity. The extraction of the transit signal from the raw data is a critical process. In the last two years, a detailed hardware and software simulation of the entire transit signal detection and extraction process has been successfully demonstrated at Ames Research Center, proving the capability of Kepler to detect Earth-like planets around other stars.

The science goal of the Kepler mission is to explore the structure and diversity of planetary systems, with a special emphasis on the detection of Earth-size planets. It will survey the extended solar neighborhood to detect and characterize hundreds of terrestrial and larger planets in or near the habitable zone, providing fundamental progress and large leaps in our understanding of planetary systems. The results will yield a broad understanding of planetary formation, the frequency of formation, the structure of individual planetary systems, and the generic characteristics of stars with terrestrial planets. Tentatively planned for launch in spring of 2007, Kepler will collect science data for four years.



Artist's concept of the Kepler spacecraft.

"The Kepler mission will, for the first time, enable humans to search our galaxy for Earth-size or even smaller planets," said principal investigator William Borucki of Ames. "With this cutting-edge capability, Kepler may help us answer one of the most enduring questions humans have asked throughout history: are there others like us in the universe?"

To date, about 80 extra-solar planets have been discovered. However, these are all gaseous-giant planets similar to Jupiter, which are probably composed mostly of hydrogen and helium and unlikely to harbor life. None of the planet detection methods used so far has the capability of finding Earth-size planets - those that are 30 to 600 times less massive than Jupiter. None of the giants discovered to date are believed to have liquid water or even a solid surface.

"From monitoring 100,000 stars similar to our sun for four years, the Kepler team expects to find many hundreds of terrestrial-type planets," said David Koch of Ames, the deputy principal investigator.

For more information about the Kepler mission, click here.

CONTOUR Readies for Summer 2002 Launch

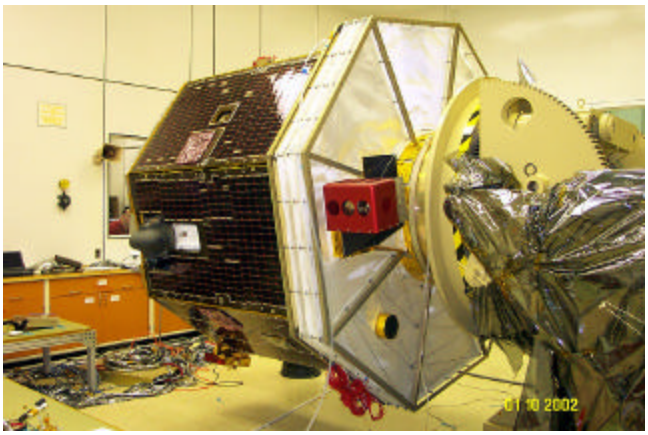
Capping nearly two years of detailed development and assembly, engineers at the Applied Physics Laboratory (APL) in Laurel, Maryland, are putting the last touches on the CONTOUR spacecraft, which will provide the closest and most detailed look ever into the icy heart of a comet.

All CONTOUR onboard systems have been tested, including its four scientific instruments (the two cameras, a dust analyzer and a mass spectrometer). APL technicians recently attached the solar panels and the final layers of the resilient, Kevlar-and-Nextel dust shield designed to protect CONTOUR from speeding bullet-like particles around the comets.

The Pre-Environmental Test Readiness Review was held on Tuesday, January 8th, to assure that the spacecraft, instruments and ground support equipment were ready to proceed to environmental testing, and to review the environmental test plans, procedures and facility readiness. An independent review board examined the configuration and test history to date, and all board members concurred that CONTOUR was ready to proceed.

On January 14th, the spacecraft was put in final configuration in the cleanroom, and then moved to the vibration facility at APL. The test sequence consisted of day-long functional testing of all the spacecraft systems, followed the next day by the actual vibration test. The following day the same functional tests as those run just prior to the vibration test were conducted again to determine if the exposure to the vibration damaged or impacted any system on board.

CONTOUR shipped to NASA's Goddard Space Flight Center in Greenbelt, Maryland, at the end of January for nearly three months of additional tests in Goddard's expansive facilities. These rigorous checks are designed to verify that CONTOUR can stand up to the shaking during launch and the harsh conditions of outer space. In May, CONTOUR will leave Goddard for Kennedy Space Center, Florida, in final preparation for launch aboard a Boeing Delta II rocket.



The CONTOUR spacecraft with solar arrays and three of the four instruments: CRISP cover, NIGMS with red protective cover, and the CFI portal through the dust shield.

Education and Public Outreach Highlights

CONTOUR's Informal Education Program is a plan to participate in outreach events through Cornell University and other institutions participating in the mission. This fall, the CONTOUR EPO lead, Laura Lautz, made a presentation at Beverly Martin Elementary School in Ithaca, New York, as part of a book fair focusing on space science. Lautz, with help from undergraduate students at Cornell, also hosted a booth on spectroscopy and space exploration at the National Chemistry Week Fair in Ithaca, New York. A CONTOUR science team member participated in the University of Texas Quest Program, giving a talk on comets to members of the local community, and also presented the CONTOUR mission as part of an undergraduate seminar course on current research at the University of Texas.

Upcoming informal outreach events include participation in a workshop for middle school girls designed to excite them about science and technology, presentations at an after school science club in upstate New York, and participation in a middle school science fair. CONTOUR is also gearing up for its participation in the Solar System Ambassador Program.

The CONTOUR Comet Curriculum Program is a plan to develop and distribute educational materials related to the mission. Currently, the EPO lead at Cornell is working to develop new lessons and compile existing materials to create comprehensive units on the use of spectroscopy to explore space, particularly comets. Cornell will host a workshop this summer that will address the needs of grades 9-12 teachers in the areas of planetary science, the study of comets, and physics. Currently, teachers are being recruited to participate in the workshop.

CONTOUR has recently updated its web site with science team biographies, a media gallery for the press, and information on the Cornell and CONTOUR Comet Challenge.

The Cornell and CONTOUR Comet Challenge

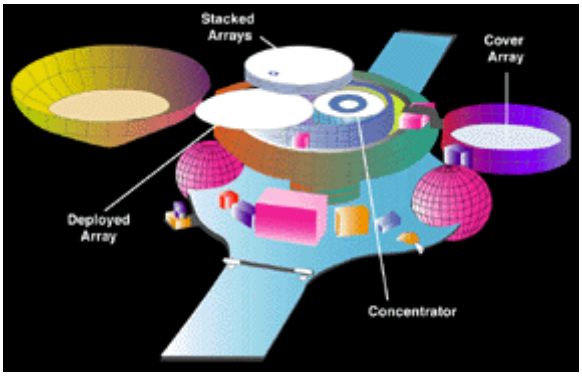
Cornell University and the Comet Nucleus Tour (CONTOUR) mission team are inviting teachers and students to participate in the CONTOUR launch activities at Cape Canaveral, Florida, in July of 2002 by developing a plan to share their excitement and experiences with their community. U.S. students in grades 5 through 12 and their teachers are eligible to participate. During the days prior to the launch, the teams will have one-on-one interactions with the CONTOUR scientists, take part in a variety of educational events on the study of comets and the CONTOUR mission, tour the Kennedy Space Center, and attend a VIP briefing with the CONTOUR engineers and scientists. These activities will culminate with a spectacular viewing of the launch of the spacecraft from Cape Canaveral. After participating in the launch activities, participants will follow through with their plan to

share their experience with other students and community members. Click here for details on the comet challenge and how to participate.

Genesis Science Collection Begins

The Genesis spacecraft went into perfect orbit insertion around balanced-gravity point Lagrange 1 on the morning of November 16, 2001, with the execution of a flawless 268-second burn. This trajectory was chosen because it takes the spacecraft and science instruments to a point in space far enough from Earth to permit collection of solar wind samples before they interact with the Earth's geomagnetic field.

The orbit insertion maneuver set up the five halo loops that Genesis will complete around L1 over a period of about 30 months, beginning the science part of the mission. While other missions have monitored solar wind in halo orbits, Genesis is the first to collect samples of solar wind and return them to the Earth for scientific analysis. The daytime return to Earth in 2004 will be a very exciting event.



Artist's concept of the Genesis spacecraft opened for collection of solar wind.

November 30th marked the official start of science collection for Genesis with the opening of the science canister. On December 3rd, the collector arrays were successfully deployed. First, the arrays that sample the bulk, coronal mass ejection and high-speed solar wind were extended. After waiting 30 minutes for the ion concentrator's temperature to stabilize, the low-speed array was deployed. Then the sample return capsule backshell was closed one degree to minimize the spacecraft's wobble. The arrays were then put into autonomous control, allowing the WIND algorithm to control their motion and position. The next day the ion concentrator was turned on, the last step to begin particle collection.

According to Principal Investigator Don Burnett, "We expect to start getting particle hits right away. This is the real focus of the mission: the start of science, leading to the return in 2004 and the analysis phase of the mission."

Where is the Genesis spacecraft now?

Follow the spacecraft in its orbit around L1. Most images are updated every 10 minutes.

Education and Public Outreach Highlights

Tune In on February 21st

Genesis will recognize National Engineers Week by bringing mission engineers, classroom teachers, and students together for a Webcast on February 21, 2002. The production will feature a classroom activity based on the Genesis *Destination: L1* education module, which debuted on the Genesis website this month. Students and teachers nationwide will have the opportunity to explore the featured Webcast activity in their own classrooms in advance. They may then submit questions about the activity, the module, or the Genesis mission in general via e-mail. Questions will be reviewed, and selected inquiries will be aired and answered by a mission project member on the day of the Webcast. Additionally, a classroom teacher and students will conduct the featured activity live in the filming studio with help from mission engineers. The Webcast will herald from the Jet Propulsion Laboratory (JPL) studios, and be archived on the JPL website for later viewing on demand.

Young Astronauts

NASA's Young Astronauts program and McREL teamed up again to bring another 30-minute program to kids around the world. On January 14 and 15, Genesis made its second appearance as the featured mission on the Young Astronauts program. Commander Dave Howe and McREL's John Ristvey featured the August 2001 Genesis launch, including video footage and hands-on activities from the latest Genesis science education module: *Dynamic Design: Launch and Propulsion*, and the upcoming module: *Destination L1*.

NEW Genesis Education Module: Launch and Propulsion

In *Dynamic Design: Launch and Propulsion*, students learn how rockets are launched, and how and why specific rockets are chosen for varying payloads. This middle school module (grades 5-9) reveals the history of rocketry and lets student teams work with and test variables that might affect the performance of a launch vehicle. In the assessment, students engage in a competition whereby they apply what they have learned about rockets to build a launch vehicle that flies as high as possible.

Stardust Gets Closer to Comet Wild 2

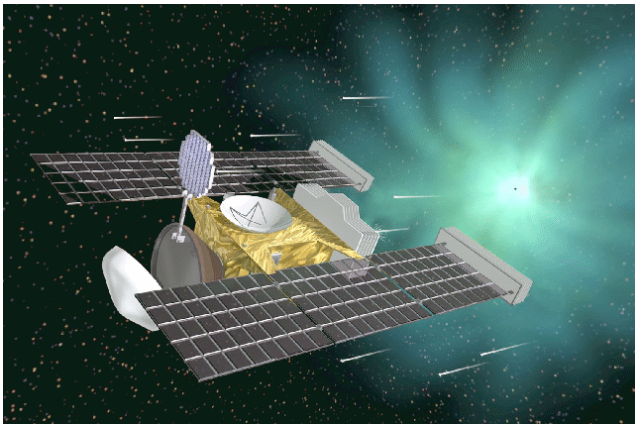
Stardust, the first U.S. space mission dedicated solely to the exploration of a comet, is heading toward an encounter with Comet Wild 2 in January 2004. The mission will return samples of comet dust and interstellar dust particles to Earth in January 2006.

In early January 2002, Stardust reached its maximum distance, 3.594 AU (334 million miles, or 538 million kilometers), from Earth.

It is farther from the Sun than any other solar powered spacecraft. At that distance, a signal takes 59 minutes 47 seconds to travel from Earth to the spacecraft and back to Earth.

On January 18th, Stardust successfully completed Deep Space Maneuver 2, the seventh trajectory correction maneuver since launch. All subsystems performed well as the spacecraft turned to an anti-sun attitude to perform the 2.65 m/s burn. The Power Subsystem battery state of charge (SOC) dropped to 95 percent before sun attitude was re-established. The predicted power SOC was 70 percent.

The Power Subsystem has been performing better than the predicted. The prediction tool uses a worst-case power load for determining the battery SOC and battery voltage at the end of each Deep Space Network (DSN) pass. For a typical DSN pass, the battery voltage ranges from 31.5 to 28.2 volts while the SOC goes from 107% to 85%. Although the power performance margin indicates that additional communication time is possible, the conservative approach will continue to be used since Stardust is the first mission to use solar panels at this distance from the sun (2.65 AU).



Artist's concept of the Stardust spacecraft.

Click here to find out where Stardust is right now.

Education and Public Outreach Highlights

Stardust has been actively seeking to expand its museum partnerships. Stardust will be joining forces with JPL's Space Place network of small community museums to better reach rural areas throughout the United States not commonly exposed to NASA and/or space exploration first hand.

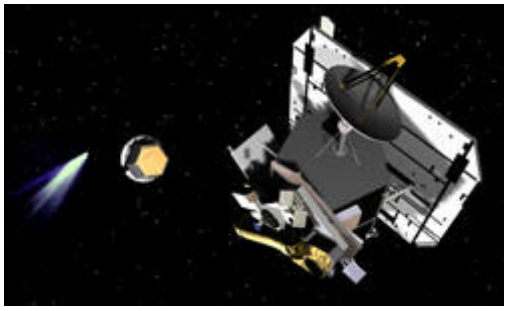
In addition to existing museum partnerships, Stardust is participating in an exhibit dedicated to Understanding Comets at the Newark Museum, New Jersey. A 1/4 scale model of the Stardust spacecraft along with a cube of aerogel will be part of a larger exhibit on display for approximately 12 months. Upcoming exhibits can also be seen at the Chabot Space and Science Center in Oakland, CA.

The November/December 2001 issue of Mercury magazine, published by the Astronomical Society of the Pacific, featured the Stardust project in an article called "Collecting Cosmic Dust."

Deep Impact Design Reviews Underway

The Deep Impact mission is proceeding according to plan, with successful detailed design reviews for the software, the instruments and the spacecraft completed in November and December. The mission's critical design review will take place at the end of January 2002.

Planned for a January 2004 launch and July 2005 encounter with comet Tempel 1, Deep Impact will be the first mission to create a huge crater on a speeding comet. Dramatic images from both the flyby spacecraft and the impactor will be sent back to Earth in near-real time. These first-ever views beneath a comet's surface and other instrument readings will provide clues to the formation of the solar system.



Artist's concept of the Deep Impact spacecraft.

Education and Public Outreach Highlights

The Deep Impact Education and Public Outreach team is at work on some unique projects. They are broadening the relationship with amateur astronomers begun in the year 2000, heading toward comet encounter in 2005. Further analysis of the images taken for the Small Telescope Science Program (STSP) continues, with the results being sent to the science team to complement their data from large telescope observations. A web page with strategies for observing Comet Tempel 1 during mission encounter is under development to assist amateur astronomers who wish to support the mission with science data and also with outreach to the public. Amateur astronomers will be a vital link between the Deep Impact mission and the public as some of them are able to offer a view of the impact of Comet Tempel 1 through their telescopes.

Deep Impact is one of the missions developing a workshop for the Girl Scouts of America this spring when Scout master trainers gather in New York to learn how to excite young women about math,

science and technology through the study of space missions.

The Deep Impact website has two new education modules. *Excavating Cratering*, created by team member Gretchen Walker, brings a new approach on cratering to the classroom. *Collaborative Decision Making*, developed by McREL, engages students in grades 7 -12 in activities that focus on collaboration and communication strategies. Students are given the opportunity to work on a current challenge facing the mission science and engineering team. This activity was conceived with input from the mission's master teachers. Another educational activity in development, *Why Explore Comets?*, will extend across grades K - 12.

Many members of the Deep Impact team continue to be active in public and educational outreach from Hawaii to Maryland at locations like the Maryland Technology Showcase and L.A.'s BEST, an after school program for Los Angeles' inner city schools. Deep Impact continues to partner with Space Explorers, Virginia Space Grant Consortium, Challenger Centers, McREL, the Girl Scouts of America, Maryland Science Center, Fiske Planetarium, Solar System Ambassadors, Women in Science, Solar System Educator Program, and "From the Sun to the Star Nations."

MESSENGER Development Continues

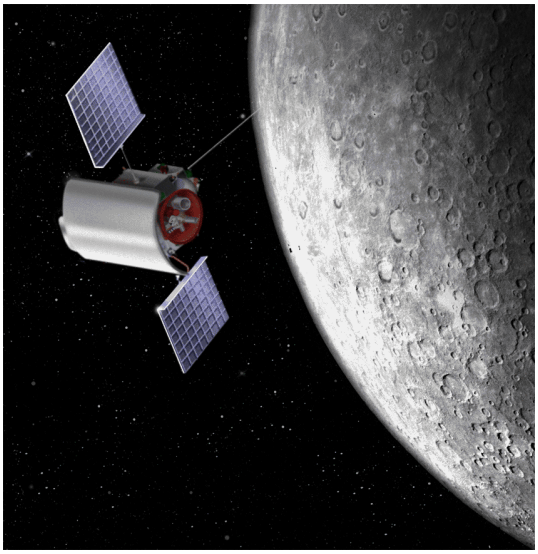
The MESSENGER schedule remains on track. During the month of December, Science Team members continued to meet regularly with lead system and instrument engineers to clarify scientific requirements on mission design and implementation. Weekly meetings of instrument leads continued to sharpen the designs of MESSENGER payload instruments.

A successful propulsion system Critical Design Review (CDR) was held December 11-12 at Aerojet in Sacramento, CA. This was significant as the integrated structure/propulsion system is still the critical path in the overall MESSENGER project schedule. A myriad of subsystem design reviews are ongoing and will continue in preparation for the mission CDR the week of March 18, 2002.

Recent science activities focused on matching instrument performance with the science requirements for the mission. The Mission Success Criteria were reviewed for the team at the engineering meeting on December 4. The Project Scientist attended the propulsion system CDR and verified that no material or contaminant problems have arisen in the course of the propulsion system design that could lead to instrument interference (e.g., ferrous materials with the magnetometer or radioactive materials with the gamma-ray spectrometer).

Education and Public Outreach Highlights

Plans to revise the MESSENGER website are underway, with a number of EPO team members participating.



Artist's concept of the MESSENGER spacecraft.

In December, the film crew that is working on the MESSENGER documentary was hosted at APL. They recorded the evolution of the spacecraft mock-up and its movement out of the carpentry area to the harness fabrication area. Discussions are taking place regarding the mounting of a time-lapse camera to chronicle the building of the spacecraft.

The template for the MESSENGER Education Module (MEM) lessons and activities has been developed. This template will reflect appropriate institutional design for the different grade levels and consolidate products developed by MESSENGER EPO partners. It will be distributed to the EPO Team in early January.

Discovery Dispatch

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