From the Project Manager

As most everyone now knows, when the High-Gain Antenna (HGA) was commanded to unfurl last April, several of its ribs stuck to the tower. Ever since, the Project has been working very hard to determine what is holding those ribs to the tower and what actions to take to free them. (See "Unfurling the HGA's Enigma.")

The probable scenario is that the rib-locating pins that brace a rib when it is clamped to the tower are frictionally bound in their receptacles. This binding friction is due to a loss of lubrication and an anomalously high normal force between the pinhead and the receptacle due to pin-pair misalignment ("preload"), and then digging the pinhead into the receptacle's lower surface with the deployment bending moment. The lubrication was most likely worn off in the numerous road trips between Florida and California.

By shrinking the antenna tower (using the cooling turns), we hope to reduce the "digging force" to the point where the deployment strain energy now concentrated in the few stuck ribs will overcome the preload and pop the ribs out. The July and August cooling turns did not get the tower cold enough. We are planning a December turn that will get it colder. If this does not succeed, we will alternately heat and cool (cycle) the tower in the fall of 1992, when Galileo is near 1 AU to "walk" the pins out. I am

Unfurling the HGA's Enigma

On April 11, Galileo's High-Gain Antenna (HGA) should have deployed. However, signals received from the spacecraft indicated that the antenna only partially deployed, leading to the current assumption that three of the antenna's ribs are stuck in the stowed (or closed) position, while the others are partially open. The Project has performed three spacecraft turns, the first one to warm, then the next two to cool the antenna. The antenna remains partially deployed. The last activity was a cooling turn performed August 13 through 15.

The main difficulty in accurately deducing the actual configuration of the antenna lies in the sparse amount of data available from the spacecraft. The three primary pieces of information available are derived from the motor current, from wobble identification, which tells if the antenna is deployed evenly, and from the Sun gate sensor, which is currently obscured by one of the antenna's ribs.

An HGA Deployment Anomaly Team was formed on April 11. It was chartered to develop likely failure scenarios and credible

The high-gain antenna is shown in its full deployment during pre-flight testing.
explanations for the partial deployment. Also, the Team was to assess the risks and develop supporting requirements and plans for recommended actions. The Anomaly Team consists of mechanical, electrical, thermal and materials design, reliability, and flight operations personnel from JPL and contractor personnel from Harris Corporation, the builder of the HGA.

A primary consideration in any attempt to unfurl the antenna is the Project's requirement that any spacecraft action must be safe and must not preclude subsequent deployment.

The Available Data

The HGA deploy sequence was executed on April 11, as planned, by issuing commands to turn on the deployment motors. The motors ran at higher than predicted power levels for nearly the full sequenced 8-minute period. The microswitch-controlled motor shutdown expected about 2.5 minutes after the motors were powered on did not occur. Instead, in the first 58 seconds, motor current increased to a value consistent with full available stall torque.

Preliminary analysis of the data stemming from the attempted HGA deployment, including power consumption and attitude dynamics information, suggested that the HGA was partially and asymmetrically deployed. The Sun gate sensor became partially obscured during the deployment attempt and, based on spacecraft-Sun orbital geometry, it could be concluded that antenna rib #2 was deployed 35° from the stowed position.

Attitude and Articulation Control Subsystem (AACS) wobble data indicated an asymmetric condition with the position of rib #2 being at, or very near, the maximum rib deploy position. This inferred antenna geometry was corroborated by analysis of the motor drive system configuration at stall.

Subsequent to the HGA warming maneuver, AACS data and radio frequency and antenna pattern data were reviewed. Analysis of the AACS wobble test data indicated that the wobble angles before and after the HGA heating turn were nearly identical—3.47 and 3.52 milliradians, respectively. Wibble changes as small as 0.1 milliradian can be discerned. If the HGA were symmetrically deployed, the expected post-turn wobble angle would have been near 1 milliradian.

Analysis History

By April 30, the Anomaly Team initially speculated that "one or more ribs are probably restrained in the stow position, resulting in an asymmetrical partial deployment." At that time, this was the most probable scenario, but the cause was unclear.

To verify this scenario, the Team began a comprehensive test and analysis program, including reviewing all videos and still pictures of the Galileo deployment from the Shuttle to ascertain the status of the antenna and the tip shade, continuing detailed analysis of the telemetry data, and reviewing all procedures associated with the Central Release Mechanism. In addition, the Team was evaluating the thermal differential expansion of the entire antenna tower and the feasibility of a rib tip restraint pin getting stuck, reviewing the effects of shock and vibration loads on the ribs, and testing the ball screw in a thermal vacuum.

Some of the first corrective actions considered were commanding another release of the central release mechanism (CRM), altering the thermal environment of the antenna (heating and cooling and thermal cycling), shaking the spacecraft to create a force, and turning the deployment motor on again to try to get some back drive. However, since the deployment motor would increase the friction load on the alignment pins of stuck ribs, the Team agreed that such a turn-on should not be attempted until all other efforts to free the ribs have been exhausted.

The initial scenario involved three to five stuck ribs, but now it is believed three stuck ribs are restrained in the stow position and that additional ribs may have been involved initially. No damage has occurred to the dual-drive motor/ball screw, and full capability is likely if the ribs can be opened; nor has structural failure occurred to any hardware component in the motor drive subassembly. Efforts should continue to perform an antenna tower cooling turn in an attempt to free the ribs. These conclusions are based on the close comparison achieved between
flight data and modeling data profiles and a confirming scenario demonstration deployment with the spare antenna.

**Warming Turn**

Originally, the Anomaly Team thought that heating the antenna might free the stuck ribs. Therefore, a warming turn was performed. On May 20, the spacecraft was turned about 38.2° (the largest turn to date) to provide solar heating of the HGA tower; the spacecraft angle off-Sun after the turn was about 43°. Spacecraft performance during the turn was excellent and, generally, near predicted levels, achieving the desired turn attitude within 4 milliradians. This warming turn, unfortunately, did not release the stuck ribs.

**July Cooling Turn**

The first HGA cooling turn was performed on July 10 at a solar distance of 1.84 AU. The turn pointed the spacecraft’s -Z axis about 165° from the Sun to shade the entire HGA. Spacecraft performance throughout the turn was normal; the turn angle achieved was about 9 milliradians from the expected 165°.

Having reached attitude, the spacecraft was then commanded to the all-spin mode for the duration of the nominally planned 32-hour “cold soak.” A “quick look” review of the actual temperatures indicated that all were within the allowable temperature limits or that the limits had been waived specifically for the turn. After 24 hours at attitude, the HGA element temperatures reached very near steady-state values. The HGA final temperatures achieved were compatible with those used in rib-release analyses.

Following the spacecraft’s return to the Sun-pointed attitude after the 32-hour HGA cold-soak activity, telemetry indicated that the Probe shelf temperatures were still increasing and, based on projections, could reach or exceed the pre-turn agreed-to limit of 22.5° C. Immediately prior to the start of the return to Sun point, Probe shelf temperatures had reached about 16° C. Nearly 24 hours later, Probe temperatures had gone slightly above 21° C due to thermal soak back. The shelf temperatures then stabilized. By July 15, Probe shelf temperatures had dropped to near 16° C and were continuing a downward trend.

This cooling turn did not release the stuck ribs. “We have to get colder, and we know how to do that,” said Bill O’Neil, Project Manager. “We can get it cold enough so the frictional forces can no longer hold the ribs in. This cooling turn was flawlessly executed and represents a tremendous improvement in our knowledge of cooling for the next turn.”

**August Cooling Turn**

A second HGA cooling turn occurred on August 13 at a solar distance of about 1.98 AU. This turn incorporated several changes to cool the antenna, including lowering the spacecraft bus power consumption and turning off the Plasma Wave Subsystem magnetic field sensor heater located on the antenna tower. The time at the cooling attitude was increased from 32 to 50 hours.

Gary Coyle, Galileo Antenna Task Manager, said, “This cooling turn yielded an additional antenna tower contraction of 0.004 inch compared to the first attempt.”

This was still short of what was necessary to loosen the stuck ribs. Coyle went on to state that, “The wobble identification, on August 19, and the Sun gate sensor check, on August 20, showed no change from the previous configuration of the HGA.”

For this turn, Hughes Aerospace Corporation, Ames Research Center, and JPL negotiated a Probe upper temperature limit of 33° C; this new limit represents a thermal constraint relaxation of about 11° C from the July turn. “The

A closer view of the stowed antenna shows the proposed misalignment of the mid-point restraint pins. Rather than fitting into the center of the housing, the pins were tilted out of alignment.
Probe’s temperature during this cooling turn reached 31° C,” noted Ron Reeve, Galileo Temperature Control Cognizant Engineer. “We believe the Probe remains in good shape.”

The Plasma Wave Subsystem (PWS), on the other hand, endured temperatures that went, literally, off its scale. A reconstruction of the temperature readings suggests that the PWS’s search coil preamplifier reached a temperature of -165° C. It had been qualified in pre-flight testing for a minimum temperature of -35° C.

The preamplifier is currently drawing a current, which may indicate that everything is in working order. A more detailed analysis of the effect of such cold temperatures on the instrument will be conducted at the end of September, when the PWS is next scheduled to send back data.

**Project Manager (Cont’d)**

determined and confident we will deploy the HGA. NASA Headquarters has just reiterated its full support of our approach and its commitment to the complete success of Galileo.

Except for the HGA, the Galileo spacecraft has performed superbly in now nearly two years of flight—it has been to Venus, back to Earth, and now beyond 2 AU, entering the asteroid belt. The Flight Team is outstanding and they really showed their stuff in flawlessly performing the highly nonstandard, very complicated HGA cooling turns.

For the next two months, the Flight Team will focus on Gaspra. Our October 29 Gaspra encounter without the HGA will be very little degraded—the best images about 20% less in resolution than originally planned. However, we will have to wait until the HGA is unfurled or the next Earth flyby at the latest to retrieve the Gaspra data from the tape recorder.

—Bill O’Neil

**Galileo Status: Up to Date**

During the past six months, the Project’s understanding of the spacecraft has increased dramatically. Through the routine operations and, particularly, through the anomalous events involving the High-Gain Antenna and the Command Data Subsystem, engineers are honing their skills in operating and analyzing Galileo’s signals.

The spacecraft reached perihelion at 0.9 astronomical units (AU) on January 11; thermal profiles were near the expected levels and no anomalies were observed. Now receding from the Sun, the spacecraft travels toward an encounter with the asteroid Gaspra (at about 2.1 AU) in late October 1991, prior to Galileo’s planned second Earth flyby (at 0.98 AU) in December 1992.

The Galileo status given here covers the period from November 16, 1990, to August 1, 1991. Throughout this period, a variety of spacecraft activities took place, including turn activities, maneuvers, retropropulsion module flushings, Sun acquisitions, and memory readouts.

**The Spacecraft**

During this time, the spacecraft has performed very well. There were 17 SITURNs (turn activities) performed. The November 16, 1990, SITURN, about 22°, was the largest to date and resulted in the spacecraft leading the Sun by about 12.5°. This SITURN used the P thrusters, as did nearly all of the others in this interval. However, the January 7 SITURN was performed using the unbalanced turn capability with the Z thrusters. This was the first time an unbalanced turn had been performed. The unbalanced turn demonstrated this functional capability prior to its planned use for the Trajectory Correction Maneuver (TCM-9B) in March.

The spacecraft executed the TCM-7, TCM-8, TCM-9A, TCM-9B, and TCM-10 maneuvers very well. The July 10 TCM-10 was the first Galileo turn-burn-turn maneuver and the first maneuver targeted to the Gaspra flyby aim point. Analysis of the navigational data indicated about a 0.4% underburn.

**Galileo Mission Summary***

| Distance From the Earth       | 221,822,460 kilometers (137,529,930 miles) |
| Distance From the Sun         | 290,604,960 kilometers (180,175,080 miles) (1.93 AU) |
| Distance From Gaspra          | 65,545,110 kilometers (40,637,970 miles) |
| Round-Trip Light Time         | 24 minutes, 26 seconds |
| Heliocentric Speed            | 18.92 kilometers per second (42,230 miles per hour) |
| Spin Configuration            | Dual spin—cruse mode |
| Spacecraft Spin Rate          | 3.15 revolutions per minute |
| Spacecraft–Sun Angle          | -2.5 ± 0.3° off Sun (lagging) |
| Downlink Telemetry Rate       | 40 bits per second (low rate) using Low-Gain Antenna 1 |
| General Thermal Control       | All temperatures within acceptable range |
| Powered Science Instruments   | Energetic Particles Detector, Dust Detector Subsystem, Solid-State Imaging Subsystem, and Heavy Ion Counter |
| RTG Power Output              | 536 watts |
| Real-Time Commands Sent       | 5482 commands |

*All information is current as of August 1, 1991.*
cause of these memory corruptions is being investigated vigorously. Commands were sent on November 13 to “patch” the corrupted memory location, and proper operation was restored.

As a result of Magellan Command Data Subsystem (CDS) memory failure and Galileo pre-launch memory failure predictions, the Project has been concerned about possible memory failures in the CDS. The CDS memory is composed of two strings (“A” and “B”) that control its functions. Therefore, CDS “A” and “B” memory copy activities were performed on January 8 and 17, respectively. These activities demonstrated the first in-flight use of the CDS copy capability. For these copy activities, the memory contents of the CDS “A” and “B” elements were copied from the prime memory into the extended memory. Spot-check memory readouts indicated no parity errors or anomalies. This copying will reduce the time to recover from a future possible chip or location failure.

On March 26, spacecraft safing was automatically entered in response to a CDS “B” string down condition caused by a CDS “B” reset spurious transient signal. Similar situations occurred on May 2 and July 19, which resulted in a CDS “A” string down condition. The Flight Team was able to isolate the anomaly, recreate the spacecraft anomaly and response on the test bed, and return the CDS to full operation in about a week. During a spacecraft nontracking period between July 4 and 8, the twelfth anomalous transient CDS critical controller 2A power-on reset telemetry indication occurred. As in all prior occurrences, the CDS functional operation was not impaired and, subsequently, the telemetry indicator was reset by ground controllers.

Another ongoing anomaly investigation involves the AC/DC bus imbalance measurements. As of August 1, the AC bus imbalance measurement read 45.6 volts, with the largest AC fluctuation since

Fourteen retropropulsion module (RPM) 10-newton thruster maintenance activities took place. In most instances, only ten of the twelve 10-newton thrusters were “flushed” during these exercises. The P-thrusters generally were not flushed since they have been in use for all the Sun acquisition activities. These Sun acquisitions were executed, as planned, to maintain a thermally safe Sun-pointed attitude. Following each Sun acquisition activity, the star buffer memory readout was performed. These readouts provide valuable star intensity information data, which is used to update the attitude control star catalog.

Routine memory readouts were also performed for several science instruments. These instruments gather data and the information is normally read out at periodic intervals every few weeks. This is the case, particularly, for the Extreme Ultraviolet Spectrometer (EUV), Dust Detector Subsystem (DDS), and Magnetometer (MAG) instruments. A special EUV memory readout was accomplished on November 10, 1990, in response to an observed anomaly. The readout revealed that two bits of a single byte were corrupted. The memory corruption was similar to that observed during the December 1989 four-day science checkout, but the new corruption was at a different memory location. The latest anomaly was recreated and verified on the EUV simulator at the University of Colorado. The

Galileo engineers have conducted many tests to help refine their theories about the current configuration of the HGA. Here, the four-stuck-rib scenario is recreated so testing can be conducted on this spare antenna.
last fall being only 4 Data Numbers (DNs). The DC measurement now reads 14.9 volts. The DC fluctuation is much larger than the AC one, with the greatest fluctuation of 160 DN (ranging from 8.8 to 18 volts) occurring on February 25. To provide greater visibility into the AC/DC bus imbalance anomaly, commands were sent on February 1, allowing a selected set of measurements (voltages, currents, and temperatures) to be sampled as a group every 20 seconds rather than every 240 seconds, as had previously been done. The likely cause of this anomaly, the CDS bus reset anomalies, and the CDS critical controller 2A power-on-reset telemetry anomalies is slipping brush debris in the spin-bearing assembly forming momentary conductive paths between adjacent signals.

A variety of activities occurred relating to the partial deployment of the High-Gain Antenna. These activities are covered in more detail in "Unfurling the HGA's Enigma" in this issue.

On April 11, deployment of the High-Gain Antenna was attempted. The attempt resulted in the antenna being partially and asymmetrically deployed. Since the HGA is needed to return high-rate telemetry data from large distances, the low-gain antennas are currently being used for low-rate data return. However, while the spacecraft was near Earth in December 1990, telemetry data rates as high as 134.4 kbps over the low-gain antenna were transmitted and processed by the Ground Data System (GDS). This data rate is the spacecraft's maximum designed data rate and this was the first in-flight use of this rate. The data were successfully received and processed by the GDS.

The only antennas currently used for communications are the low-gain antennas (LGAs). An LGA antenna switch event (LGA-2 to LGA-1) was successfully performed on January 31. No further use of the LGA-2 was planned. However, because of the HGA deployment anomaly, several LGA switches have been performed in support of the cooling turns.

The Probe

A Probe checkout was successfully performed on December 4, 1990. All power consumption and thermal profiles were near predicted levels. Preliminary analysis indicated Probe operation was normal and no unexpected Probe events were observed; the Probe health is excellent. The Probe's Relay Link ground system program set successfully completed its acceptance test and delivery reviews and was delivered to the Project on July 29.

Phase II MOS Design

The Phase II Mission Operations System (MOS) Design Verification Review was completed on November 9, 1990. The Galileo Review Board concurred with the MOS design changes resulting from the Venus–Earth–Earth trajectory and preliminary staffing profiles for the period from launch plus 21 months through the end of the mission. The objective was to develop a realistic work plan considering MOS design items and the continuing operational support requirements. Each of the items was discussed, scheduled, and assigned to a specific office or team for work.

Ground Data Subsystem

The German Space Operations Center (GSOC) has reported that installation of upgraded telemetry and command computer hardware has been completed and regression testing of the software and complete system has begun. GSOC is in the process of testing German ground data system capabilities in preparation for its planned support of Galileo cruise science operations, which were scheduled to begin in September 1991, but which have been delayed due to the HGA anomaly.

The Project Change Board approved the Flight Projects Support Office Multimission Image Processing Subsystem delivery for supporting Galileo. The new delivery provides a number of corrections and performance improvements needed for supporting the Gaspra encounter.

Other software delivery activities have been completed, including modifications and corrections to programs needed to support the Gaspra encounter.

The October 1, 1991 software development and delivery activities have begun. A total of 23 program sets are currently planned for delivery. The deliveries will provide updates to capabilities necessary to support uplink design activities at the second Earth encounter, final tour design activities, and Gaspra non-real-time downlink support enhancements.

The Space Flight Operations Center Phase I hardware installation started with the placement of the first workstation in the Galileo Mission Support Area (MSA). A total of 12 workstations will be installed in the MSA as part of the Phase I installation scheduled for completion by mid-August. The Phase I hardware will be used for familiarization and early testing prior to the formal delivery of the Galileo software next year.

Sequence Development

The Project reviewed and approved the final sequence and command products for several control sequences. These sequences covered spacecraft activities from: December 17, 1990, to February 18, 1991 (VE-12); February 18 to April 29 (VE-14); April 29 to July 22 (EE-1); and September 3 to October 28 (EE-2 prime). In addition, because of the CDS bus reset anomalies, numerous real-time mini-sequences have been developed to carry out the spacecraft's required engineering and health- and safety-related

— see page 8
Tracking the Sequence of the SROP

Between the domains of the Project Office, which decides how Galileo's entire mission will proceed, and those of the Mission Design and Sequence Teams, which detail the spacecraft's events to a millisecond, lies the realm of the Science Requirements and Operations Planning Team (SROP).

From the Galileo science investigators and their JPL colleagues, the Science Coordinators, the SROP Team collects the information necessary to create scientific sequences, supervising the integration of the many observation requests into a single event sequence.

Team Chief Jim Dunne leads the SROP's three sequence integrators and three technical support people. Karen Buxbaum (Deputy Team Chief), Dave Bliss, and Paul Schulte, the sequence integrators, orchestrate the resolution of conflicts among the various experiment observation requests and act as contacts with the Mission Design, Orbiter Engineering, Navigation, Mission Control, and Sequence Teams, and with the Science Coordinators. Three technical support people—Valerie Henderson (Technical Support Lead), Julio Osornia, and Alicia Albaugh—assist the Science Coordinators in generating the sequence products.

These seven people comprise the SROP staff and are the focus for the science sequence inputs, acting as the executive team for the science planning process. An additional 20 people on the science teams act as Science Coordinators, interpreting scientists' needs and negotiating for the best time in the sequence for their instrument.

The larger SROP includes the SROP staff, the Principal Investigators, the Co-Investigators, and the Science Coordinators. This group develops the scientific guidelines and detailed contents for each activity plan. The SROP staff and the Science Coordinators then convert the decisions from these meetings to a level usable by the Mission Design Team (MDT) and Sequence Team. The SROP develops Galileo's science sequencing plans first at the "activity" level, where the events are timed to about a minute, and then at the "plan" level, where two-thirds of a second makes a difference.

The full SROP's deliberations revolve around Galileo's scientific encounters, including the asteroid Gaspra flyby. "Scientific content is always determined by the investigators," Jim Dunne emphasized. "The Science Coordinators are able to adequately represent the Investigators in the detailed sequence development because they know, by long-term interaction with the scientists, what the scientists want to accomplish."

The Science Coordinators put together science sequences using the SROP-developed OASIS program. OASIS merges the files from all the coordinators with the MDT-generated "skeleton" plan. (The skeleton plan contains the necessary engineering and navigation activities for the planned period, provided by the Orbiter Engineering and Navigation Teams, and the Deep Space Network tracking support profile, provided by the Mission Control Team.) OASIS also identifies and consolidates science conflicts into a single "conflict file."

Next, the SROP sequence integrator works with the Science Coordinators to resolve the conflicts either by changing the timing of an event or by sharing resources among several instruments. Such sharing often allows two instruments to occupy the same observing period by quickly switching from one instrument to the other. Each conflict must be carefully negotiated by the Science Coordinators, the sequence integrator, and the cognizant PIs.

The SROP members then document these agreements and generate an activity plan for final review by the Investigators in a meeting of the full SROP. By the time the activity plan is completed and published by the MDT, the SROP has worked with just about every flight team on the Galileo Project.

In addition to science sequence design, the full SROP has also deliberated on such things as when...
Galileo should arrive at Jupiter and delivers recommendations to the Project Science Group, the senior science advisory group under the direction of Torrence Johnson, the Galileo Project Scientist. In the case of the Jupiter arrival date, many factors influenced this decision—for trajectory reasons, Galileo needed to come close to Io; for the magnetic fields instruments, Galileo had to traverse the Io torus; to deliver the Probe into the Jovian atmosphere, Galileo's trajectory had to pass through a certain point; to make darkside measurements of Jupiter, Galileo needed to pass on the far side of the planet; and to retrieve any data at all, the SROP had to accommodate the allocation schedule of the Deep Space Network. Such deliberations and recommendations by the full SROP are complex and involve a plethora of compromises.

Next year, the SROP will develop a recommendation as to which of the Jovian satellite tours generated by the Navigation Team should be selected. One of the things the Team will consider will be how to maximize the number of satellite encounters and how to strike a balance with the conflicting observing regimes of different instruments. One conflict, for example, involves the Solid-State Imaging System, which needs to image a well-lit landscape with deep shadows for contrast, and the Near-Infrared Mapping Spectrometer, which requires a well-lit landscape with no shadows. The same tour must accommodate both instruments, with some obvious compromises in store. After the SROP negotiates such compromises, the Project Science Group has the final authority.

The next few years will be busy ones for the SROP. The plans for the Gaspra flyby are now at the final stage. Satellite tour selection will begin in January and continue through June 1992. The Orbit Planning Guide, the overall mission experiment design by the PIs and the first-order agreements for sequencing, is due in September 1992. (The Orbit Planning Guide for the 1986 mission was completed in 1985, and the Team may be able to reuse a significant portion of that Guide for this mission.) Activity-level plans for the remainder of the mission will continue through 1994 for whichever tour is selected.

The soft-spoken gentleman who will continue to lead this group of negotiators is Jim Dunne. Just as the products of his Team move from person to person, becoming more and more sophisticated with handling, so too has Jim's work in aerospace become more sophisticated as he has moved from project to project. Jim received masters' degrees in biology and geology from Hofstra University and then a doctorate in mineralogy from Columbia.

In 1960, he began working at Philips Electronic Instruments, researching applications for an advanced x-ray instrument for mineralogy. "But," Jim notes, "I became more interested in instrument design than in applications. I became an instrument scientist rather than a mineralologist."

Moving into this new arena, Jim worked on the development of an x-ray diffractometer for the Surveyor Project, elucidating the mineralogical and petrological capabilities of this instrument. He moved with the instrument to JPL in 1964, to head up a program on the application of x-ray diffractometry to lunar studies.

As Surveyor finished, the Mariner 6 and 7 missions were looking for someone to take charge of their image processing. Enter Jim Dunne. Jim decided he had become "more interested in the spacecraft than in an individual instrument." Later, as Project Scientist for Mariner 10 (Venus Mercury), Jim received valuable experience that would help him in his later negotiations in the SROP. More negotiation experience followed as he oversaw Seasat's ocean experiments.

In addition, he participated in several project studies, including the proposed American Comet Halley intercept mission.

During this time, he led a working group of the International Consultative Committee on missions to Halley's Comet. His group initiated the Pathfinder experiment, which used imaging data from the Soviet Vega spacecraft to provide final course adjustments to the European Space Agency's Giotto spacecraft, both members of the Comet Halley armada. Later, he was also the Manager of JPL's contribution to the Soviet Phobos mission to Mars.

Jim was appointed Galileo SROP Team Chief in 1983, and just this year was also named the Science and Mission Design Office Manager.

Up to Date (Cont'd)

activities. Of course, additional sequences have been prepared and sent for the various HGA cooling turns.

Because the HGA warming maneuver did not result in any perceptible changes to the HGA, the Project directed that the Gaspra encounter be planned using the low-gain antenna and the onboard data storage capabilities of the Data Management System (DMS). All work on the EE-2/EE-3 sequences that presupposed the availability of a fully unfurled HGA was terminated. New sequences EE-2 prime and EE-3 prime are being developed to carry out the Gaspra encounter.