From the Project Manager

Major milestones were achieved in the integration and test areas this summer, well within schedule.

In the Spacecraft Assembly Facility, integration and testing continues with the hardware and software for the spacecraft's command and data subsystem (CDS) and attitude and articulation control subsystem (AACS), as well as with science instruments. The protoflight units of the plasma subsystem (PLS), solid-state imaging subsystem (SSI), magnetometers (MAG), near-infrared mapping spectrometer (NIMS), and ultraviolet spectrometer (UVS) were delivered to SAF and integrated on the spacecraft. (The photopolarimeter (PPR), dust detector subsystem (DDS), energetic particles detector (EPD), and plasma wave subsystem (PWS) had been delivered earlier.) Assembly of the flight despun bus, lower Centaur adapter, radio relay antenna (RRA) boom structures, and flight scan platform was also completed.

Environmental testing of the Development Test Model (DTM) continued as the spacecraft underwent cruise and launch modal, acoustic, and pyro shock tests. The DTM is now undergoing static tests to verify structural loads.

In late July, the second drop test of the Probe validated the corrected parachute shroud configuration. In September, the protoflight Probe was electrically connected to the Orbiter system for the first time as end-to-end data tests were conducted. Work continues at Hughes Aircraft on the flight unit of the data and command processor.

Participants in the Heavy Ion Environment Workshop at JPL discussed the threats presented by the heavy ions in the regions surrounding Io, and helped the Project establish a design model environment. On the basis of this information and extensive system, subsystem and component part analyses, the Project established a plan to prevent single-event upsets in this environment.

Many of you turned out for the showing of the DTM at our August Open House, and enjoyed the opportunity to show off your work to your families and friends. In both size and complexity, it is an impressive spacecraft.

— John Casani

Microphones placed around the DTM in the acoustic chamber pick up the noise levels created by large horns to simulate noise levels in the Shuttle's payload bay.

Team members and their families take a close-up look at the full-scale test model of the Galileo Orbiter.
Meet the Team — John Givens

John Givens is a man of many talents. As the Galileo Probe hardware manager at Ames Research Center, he has a vital role in the fabrication and delivery of the atmospheric probe.

Along with a team of Ames engineers under him, John is responsible for the day-to-day management and monitoring of the Probe development by the Hughes Aircraft Company. In addition, he is responsible for the hardware interface with project management at JPL. Thus, his job is a marriage of both technical challenges and personal interactions. The latter, he says, is the most challenging part, as human behavior is never as predictable as that of hardware.

He reports that the Probe work is progressing well, and that the data and command processor (DCP) problem is being resolved so that all the schedule milestones can be met. In fact, he says, it is the very maintenance of a schedule, set goals, and the challenges of daily crises that enable him to enjoy his project work so much.

Originally a music major at the University of Washington and the Curtis Institute of Music, John decided to switch to physics. After graduating from Washington, he went to work at Ames in 1961 doing research in high-speed entry and ballistic heating characteristics of projectile forebodies. He was also involved in meteor research during this time. He next worked on the Pioneer Venus mission as a thermal engineer, and was also a science engineer on the spacecraft.

John met his wife Dorothy while both were playing with a church orchestra in Philadelphia. They live in Sunnyvale with their two sons, while their daughter, a student at the University of California at Irvine, is spending the current school year in France. John still plays bassoon and gives private lessons. His playing is a relaxing contrast to his busy workdays at Ames, although his students sometimes require him to apply some of his management skills. Dorothy also gives flute and piano lessons privately.

Galileo Open House

On August 14, over 1,500 invited members of the Galileo team at JPL, their guests and families, visited the Laboratory to view the full-scale Galileo Development Test Model (DTM). The DTM is the structural twin to the flight spacecraft now being assembled at JPL, but it does not include the electronics or other flight equipment. It is used in testing to verify the structural analysis used in the design of the spacecraft.

The spacecraft was situated in the open area between the acoustic chamber (where sound and pyro shock tests had been completed only a few days previously) and the modal pit inside the Environmental Lab (Building 144).

In addition to viewing the DTM, guests were invited to visit the Space Flight Operations Facility (Building 230) and see multi-media slide shows in von Karman Auditorium and other conference rooms. More mission information was available in the mall.
Single Event Upsets

As a result of volcanic action on Io, the innermost of the large Galilean moons of Jupiter, particles (actually heavy ions) of sulphur and oxygen are present in the space surrounding the planet. These particles form a part of the Jovian magnetosphere. Although the origin of these particles is the moon Io, the volcanoes provide enough velocity for them to escape from the gravitational field of the moon and to become elements of the magnetosphere around Jupiter.

The heavy ions diffuse both inward and outward from the planet. Many of the particles diffuse outward to 20 to 50 times the radius of Jupiter (RJ, measured from the planet's center), where they are accelerated by an interaction with the massive Jovian magnetic field. Having been highly energized, these particles begin to diffuse away from the region of energization, once again some going inward and some outward. The outbound ones are of no concern, but the inbound ones get accelerated even further by the increasing magnetic field.

The most critical phase of mission operations for Galileo occurs at the time of the spacecraft’s closest approach to Jupiter (4 RJ). The major mission events take place during this critical phase — the transmission of the Probe data to the Orbiter, followed by the relay of that data to the Earth, and the Jupiter Orbit Insertion (JOI) maneuver that slows Galileo into an orbit around the giant planet. It is during this critical phase that the energetic particles of sulphur and oxygen are a threat to Galileo. These heavy ions are capable of penetrating the delicate electronics in the spacecraft and causing a stored computer bit to change its value from a “0” to a “1” or vice-versa. This “bit flip” is referred to in engineering jargon as a Single Event Upset (SEU). A single bit flip in one of Galileo’s computer memories could trigger a chain reaction of erroneous commands with disastrous results.

Over a year ago, the Project started its detailed study of the SEU phenomenon. The study was directed at understanding not only the heavy ion environment around Jupiter based on Voyager data, Pioneer data, and theoretical models, but also the impact of possible SEUs on the Galileo spacecraft and mission. In August this study was finished. The conclusions of the study were that, for the current Galileo spacecraft design, the probability of a mission catastrophe due to an SEU in either the Attitude and Articulation Control Subsystem (AACS) or the Command and Data Subsystem (CDS) was unacceptably high.

As a result, the Project has embarked on a major development of a new processor for the AACS that will not be sensitive to the sulphur and oxygen particles that can cause SEUs. In addition, two key part types in the CDS will be replaced with new part types to make that subsystem immune to Single Event Upsets. During the next year, these new activities for both the AACS and the CDS, together with the previously scheduled system testing activity, will provide significant challenges to the Galileo team.

— Gentry Lee

In mid-September, the Probe was brought to SAF from Hughes for 2 weeks of tests with the Orbiter.
Q.: How deep will the Galileo Probe penetrate into Jupiter's atmosphere, and what factors will limit its performance as it descends to the deeper regions?

A.: The Probe is designed to successfully return data to a depth of 10 bars — ten times the atmospheric pressure at Earth's sea level. It is estimated that the Probe will reach this level about 40 minutes after entering the atmosphere, at a depth of about 90 kilometers below the one-bar level. The combination of increasing temperature and pressure will affect the behavior of selected subsystems as the Probe descends deeper into the atmosphere, but the critical elements are the Probe's battery, which supplies power, and the radio relay link to the Orbiter (including the transmitter, antennas, and environmental factors such as turbulence). Current estimates indicate a high probability that the Probe will still be operating at 20 bars (estimated to be at a depth of about 130 kilometers), and the Orbiter will be ready to continue listening to the Probe for as long as 75 minutes to capitalize on this "extended Probe mission." Eventually the Probe will be crushed and then melted as it continues to fall deeper and deeper into the ever-increasing temperature and pressure depths of Jupiter's atmosphere.

Q.: What will happen to the Galileo Orbiter after its nominal 20-month, 11-orbit mission?

A.: Many factors enter into the answer to this question. However, factors such as the accumulated amount of radiation received while orbiting Jupiter, collisions with high-energy atomic particles, and the amount of maneuvering propellant remaining will help decide the fate of the Galileo Orbiter. Depending upon the "health" of the engineering subsystems and science instruments on-board Galileo, the spacecraft could continue to encounter satellites, observe Jupiter's polar regions, or fly through the "dusk" region of Jupiter's magnetosphere. In time, Galileo's orbit may eventually decay and the spacecraft might spiral into Jupiter's atmosphere like some Earth-orbiting satellites do from time to time.