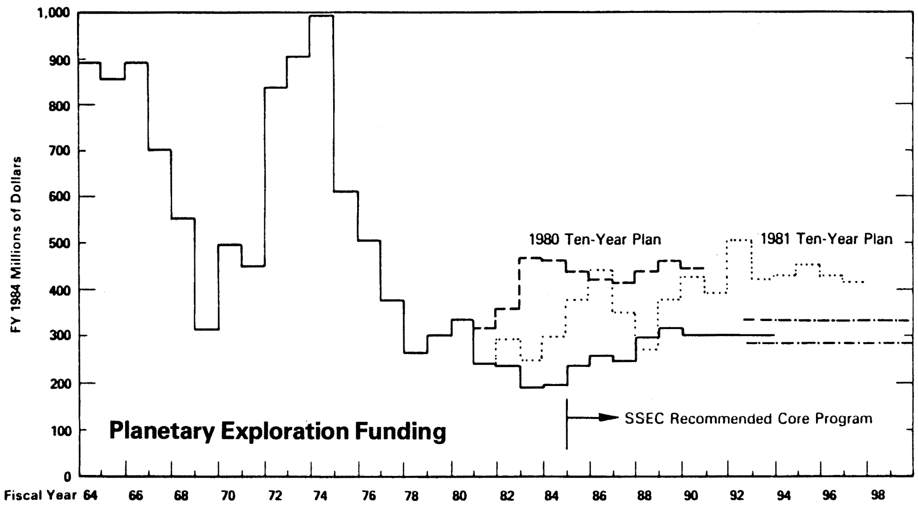
A New Path to the Planets

A new report suggests radical changes to resuscitate the U.S. planetary program



The Solar System Exploration Committee's proposed level funding for planetary research contrasts with 1980 and 1981 NASA models and the ups and down of the past.

By JONATHAN EBERHART

The entire era of planetary exploration by spacecraft, in a sense, has been its Golden Age. Beginning with the Mariner 2 probe's 1962 confirmation that the surface temperature of Venus is high enough to melt lead, it has been two decades of discovery and knowledge that were simply unavailable to the millennia of sky-watchers that came before. Each new answer has provided its own legion of questions, many of them previously inconceivable. And yet, in recent years it has seemed to many concerned scientists and others that the whole epoch has been in danger of coming to an end.

For seven years prior to the Reagan administration's fiscal 1984 budget, which includes some funds to begin a cut-down version of a radar-equipped spacecraft to map the surface of Venus, the National Aeronautics and Space Administration had not been allowed to start a new planetary exploration mission. Even the money to continue analysis of planetary data already in hand has grown scarce, to the point at which graduate students and established scientists alike have been transferring their attentions to different livelihoods, threatening the very field of planetary science.

In 1980, NASA's then-administrator Robert Frosch commissioned an ad hoc group to seek a way out of the dilemma. Called the Solar System Exploration Committee, it was asked to "translate the scientific strategy developed by COMPLEX [the National Academy of Sciences' Committee on Planetary and Lunar Exploration, long a guiding body in identifying the important questions to be asked] into a realistic, technically sound sequence of missions consistent with that strategy and with resources expected to be available for solar system exploration." Countless NASA reports over the years had proposed "wish-lists" of new planetary ventures, some of which had even found their way to reality, but the times were clearly changing. Early evidence (though budgets were already declining) showed up in the stark lack, year after year, of any follow up to the remarkable successes of the Viking Mars mission (Voyager was already in the works). Opportunities to visit Halley's comet came and went; chances to provide global data about the moon, possible only because of the vast investment in the Apollo experience, were raised, re-raised and dropped. Other missions, as well as plans to develop key new technologies for future ones, fell by the wayside. In essence, Frosch's message could be said to have been: "It looks as though we're going to have to sink or swim. The old ways are not helping. Can we do no better than drown?"

The SSEC's response, just being published (though portions have been known for months — SN: 10/30/82, p. 277), is ... another wish-list — a group of proposed planetary missions extending through the end of the century. Furthermore, in what might seem like the height of audacity, given the committee's whole raison d'etre, the report is presented almost as a package deal. Not a grab-bag from which to choose a couple of tempting examples, but a 14-mission set that the SSEC calls an essential "core program," whose very nature — effective science at reduced cost — depends on its continuity.

A major influence on the cost of a planetary mission, the SSEC believes, is the size of its "inheritance" — the amount of hardware and software development that can be incorporated from its predecessors. When various factors such as declining budgets push successive missions farther apart, the inheritance shrinks, as formerly used technologies and systems are replaced by others. The resulting higher costs can reduce the frequency of missions still further, which in turn can enhance another effect: the feeling that, with new projects so widely spaced, each must encompass a greater range of scientific investigations, at corresponding expense.

Additional problems can arise when a mission or its spacecraft must be changed after it has already been approved. On more than one occasion this has occurred when an approved design has been predicated on some key technology that was still under development, but that then failed to come through on time. NASA's first interplanetary probes, in fact, Mariners 1 and 2, were originally to have been 1,100-pound spacecraft, based on the assumption that the high-efficiency Centaur upper-stage rocket would be available to send them to Venus (Mariner 1 suffered a launch malfunction and never reached its destination). But the Centaur program was delayed, forcing a switch to an alternative rocket, and Mariner's design weight had to be reduced by nearly 60 percent — cutting back its science payload — only one year before its launching.

The SSEC's core program, besides following the general "science strategy" advocated by COMPLEX, is intended in part to reestablish "a critical level of flight activity that is necessary for a healthy scientific program." In addition, however, it is "designed for a realistic, sustainable budget so that stability can be restored to the planning and implementation of new missions ..." In the early 1960s, NASA's planetary exploration funding reached as high as $900 million (in FY 1984 dollars) during the period that covered development of the Mariner 9 Mars orbiter and the various Rangers, Surveyors and Lunar Orbiters that paved the way for the manned Apollo landings on the moon. Later in the decade, it dropped to barely a third of that amount, then shot up higher still to cover the elaborate Viking and Voyager missions, and finally (in fact before the Vikings had even reached Mars) began the precipitous drop that has had researchers worried about the future of the whole planetary program.

The SSEC, in proposing more but simpler missions, seeks an end to the erratic funding pattern that has sometimes been referred to as "the planetary roller-coaster," in favor of level funding at about $300 million annually. ("Ten-year plans" proposed by NASA itself in 1980 and 1981, according to the SSEC, envisioned amounts closer to $400 million, about twice the present level.)

Conspicuously missing from the list, in contrast with many such planning exercises in the past, are missions built around surface-roving vehicles, hardrock sample-return vehicles, low-thrust propulsion stages (such as the Solar Electric Propulsion System, whose lack of readiness helped doom plans for a U.S. rendezvous with comet Halley) and other projects requiring large funding peaks or major technological advances.

The first item in the core program is a Venus Radar Mapper (the one in the Administration's FY 1984 budget), which evolved from an attempt to save the essence of a previously proposed project called the Venus Orbiting Imaging Radar by cutting its cost in half. Much of VRM's "inheritance" would come in the direct form of spare parts or designs from other planetary spacecraft (Viking, Mariner, Galileo, etc.), as well as from an earth-orbiting satellite and even the space shuttle. It would be launched in 1988.

The SSEC's other core-program missions to the inner solar system would take advantage of another kind of inheritance: adaptations of existing designs for earth-orbiting weather and communications satellites, comprising a class of spacecraft that the committee has dubbed "Planetary Observers." The first of this batch (and second only to VRM in the SSEC's overall priorities) would be a Mars Geoscience/Climatology Orbiter, envisioned for a 1990 launch and designed to study the planet's global mineralogy, topography and water abundance among various aspects. Other inner-solar-system missions on the list include:

- Lunar Geoscience Orbiter — A low-altitude (50 to 100 kilometers) polar-orbiting vehicle equipped to gather a variety of global multispectral, gamma-ray and other data, which could be important in future planning regarding uses of extraterrestrial resources or a manned lunar base.
- Venus Atmospheric Probe—Dropped off by a flyby craft, it would be sent to yield trace-gas measurements about 10 times more accurate than those of Pioneer Venus.
- Mars Surface Probe — A javelin-like "penetrator" providing seismic, meteorological and solid-rock chemical data.
- Mars Aeronomy Orbiter — To study the planet's upper-atmospheric and ionospheric interactions with the solar wind.

For missions to the outer planets, the SSEC advocates getting the most out of shared technology through use of a modular spacecraft called Mariner Mark II (now under study at JPL) that could be adapted to a variety of diverse designs:

- Titan Probe/Radar Mapper — A high-priority mission, to be launched between 1988 and 1992, it would send a modified version of the Galileo Jupiter-atmosphere probe into the thick clouds of Saturn's biggest moon, while the Mariner Mark II orbiter or flyby that carried it makes radar maps of the surface.
- Saturn Orbiter — It would provide extensive coverage of the planet's satellites, as well as long-term observations of the rings.
- Saturn and Uranus Flyby/Probe missions — They would gather atmospheric data similar to Galileo's Jovian measurements, though without the costly Galileo orbiter.

The multipurpose Mariner Mark II would also be used in missions to comets and asteroids, which some researchers feel may be among the solar system's most important objects, though none has yet been visited by spacecraft.

- Comet Rendezvous/Asteroid Flyby — One of the core program's highest-priority missions (a 1990-92 launch), it would study an asteroid during a close pass on the way to a velocity-matched cruise beside a comet.
- Comet Atomized Sample Return — It would collect samples of cometary dust and gas on the fly, returning them to earth for laboratory analysis.
- Multiple Mainbelt Asteroid Orbiter/Flyby — It would study a variety of asteroid types as it passes on the way to taking up orbit around one for a detailed look.
- Earth-Approaching Asteroid Rendezvous — A long-term look at one of the several dozen known asteroids (out of about 1,000 suspected) whose orbit crosses earth's, making it possibly geochemically different from mainbelt asteroids and a possible source of accessible extraterrestrial materials.

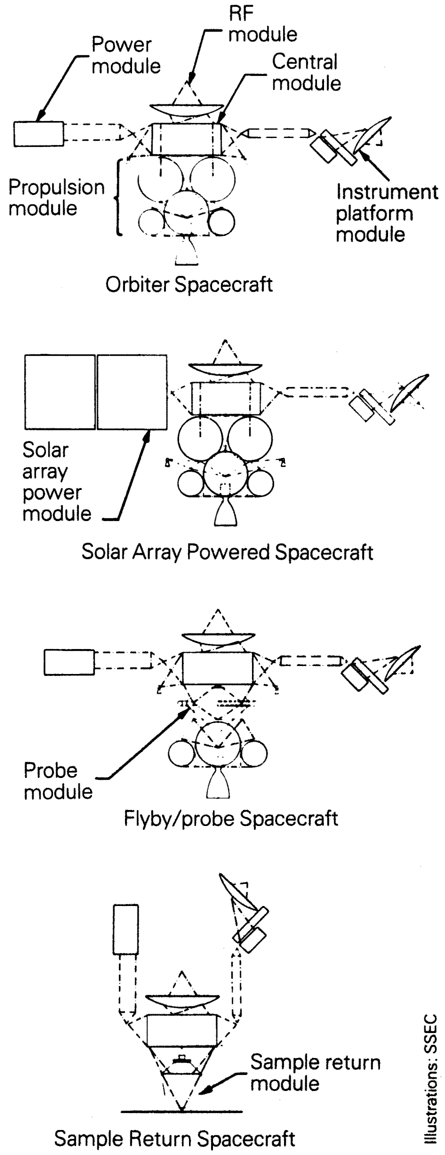
The SSEC plan also urges prompt development of a mission-operations system that will be compatible with the wide-ranging missions, and that will include shared techniques for data-handling and spacecraft control — often a significant fraction of the cost of a long-duration flight.

Step one in the plan is the Venus Radar Mapper. In FY 1985, says the committee, a number of steps should be taken: the restoration of planetary research-and-analysis funds to their FY 1981 level, to provide the best preparation for the upcoming missions; inclusion of preliminary funds to begin work on the Planetary Observer and Mariner Mark II spacecraft, as well as preparations for the Mars Geoscience/Climatology Orbiter.

The committee advocates a number of missions that are not in the core program, such as one using Galileo spare parts and designs for a detailed study of Saturn (different from the smaller, core version) and another to spread a network of penetrators across Mars. In addition, it is now at work on the report's second section, a consideration of more challenging missions to be pursued when national priorities permit.

Meanwhile, however, several SSEC members have noted, the plan's future may well hinge on acceptance not only of its first couple of missions, but of its philosophy. □

Mariner Mark II Variations



Illustrations: SSEC

The proposed Mariner Mark II modular spacecraft is shown here in various versions, including (top to bottom): A Saturn orbiter; a similar vehicle but with solar rather than radioisotope thermoelectric power, for use with missions whose payloads include gamma-ray spectrometers; a flyby carrying an atmosphere probe; and a craft for collecting cometary gas and dust samples for return to earth.