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The L-5 Society was formed in September 1975 with the purpose of promoting space development in governmental, industrial and private sectors. L-5 is the abbreviation for the Lagrange libration point number five, a proposed site between the Earth and the Moon for the final meeting of the L-5 Society before the turn of the 20th century. The L-5 Society merged with the National Space Institute in 1987 to form the National Space Society (www.nss.org).

The International Solar Polar Mission evolved into the Ulysses Mission (http://en.wikipedia.org/wiki/Ulysses_(spacecraft)), which was launched on October 6, 1990 on space shuttle Discovery (STS-41) and decommissioned on June 30, 2009 after a successful mission.

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International Solar Polar Mission

By Anthony Scott Mize

If Murphy has a law of space science, it would go something like this: If there's any way for government bureaucracy to plague a valuable space mission, it will. Predictably, this fate has befallen the International Solar Polar Mission (ISPM), a cooperative effort between NASA and the European Space Agency (ESA). Designed to be the world's first space mission to travel out of the ecliptic plane and to be ESA's first deep space probe, ISPM has had to endure potentially fatal budget cuts from both the Carter and Reagan administrations. Now, as a result of strong protest

from Europe and adverse US reaction, Congress has given ISPM a reprieve, pending a National Academy of Sciences (NAS) review of the mission.

The concept behind ISPM is not new. As early as 1959, space scientists acknowledged the desirability of a probe that would travel far out of the ecliptic, the plane defined by the orbit of the Earth. The orbits of most planets lie within a few degrees of this plane, and it approximately coincides with the Sun's physical and magnetic equators. The scientists believe that outside of the ecliptic conditions and phenomena such as solar wind and magnetic fields may be quite different from those observed from the ecliptic. Data gathered by an out of the ecliptic space mission could provide important new clues as to the structure, internal dynamics, and environment of the Sun. The mission would also provide a unique vantage point from which to gather valuable information.

It was not until 1974, however, that NASA and the eleven-member ESA, then the European Space Research Organization (ESRO), initiated joint studies and international symposia to assess the scientific value of an out-of-the-ecliptic mission. By 1977, NASA's Jet Propulsion Laboratory completed recommendations for the mission configuration and scientific package complement that became the basis for the present ISPM. Finally, a March 1979 memorandum of understanding (MOU) between NASA and ESA, which detailed the responsibilities of each agency in the mission, sealed the deal for a February 1983 launch. The mission would involve two spacecrafts, one from each agency. In that same year, NASA awarded TRW an $80 million contract for the American spacecraft and ESA awarded Germany's Dornier Systems and the STAR Industrial Consortium a $55.8 million contract for the European counterpart. The total program cost to NASA is about $400 million compared to approximately $200 million for ESA.

In the latest mission configuration, the two spacecraft would be launched in tandem from the Space Shuttle using a Centaur/Thiokol Star-48 inertial upper stage (IUS). Soon after the IUS stages have finished firing, both spacecrafts, which have already been "spun up" (put into a spinning motion) to maintain stability, separate and assume trajectories hat will put them approximately a million miles apart. The initial destination of their fourteen month ecliptic cruise phase is Jupiter, where they will take advantage of the strong Jovian gravitational field to slingshot them out of the ecliptic. In their mirror-image trajectories, the American probe will overfly the southern polar region of Jupiter and swing up north of the ecliptic, while the European spacecraft will overfly the northern polar region and swing south of the ecliptic. The maneuver is known as the Jupiter close approach phase. The spacecrafts will then recross the Solar System toward the Sun, pass over the solar polar areas, and swing back through the ecliptic on the other side of the Sun. After this solar cruise phase, the American probe will end up south of the ecliptic, the European north of it. Four and one-half years after launch, the mission will officially be terminated.

Each spacecraft will carry both American and European experiments to measure a variety of phenomena. In most cases, both spacecrafts house experiments to measure a certain phenomenon, but a few of the nine experiments on each probe have no counterpart on the other. During the ecliptic phase, they will measure the interaction of charged particles, interplanetary gas and dust, and the solar wind. The month-long Jupiter close approach phase will provide an opportunity to measure Jupiter's magnetosphere, radio emissions, and the effect of Jovian satellites on its radiation belt. In the solar cruise phase, the probes will gather data on the solar wind, magnetic fields, solar radiation, cosmic radiation, interplanetary gas and dust, and the solar corona.

One feature of the NASA probe which makes it more sophisticated and expensive than the ESA probe is a despun (not spinning with the rest of the spacecraft) platform. The platform houses a white light coronograph and an X-ray/extreme ultraviolet telescope (collectively known as the CXX), which will take pictures of the Sun and map the structure of the solar corona. This is the only equipment of its kind on either spacecraft.

One of the things that makes ISPM extremely valuable is that *two* spacecrafts will be taking simultaneous measurements of many phenomena. The data can be correlated to construct three-dimensional models, as opposed to simply two-dimensional ones, of the phenomena measured. The existence of two widely separated probes also allows for the pinpointing of solar and cosmic occurrences through triangulation techniques.

The solar cruise phase, wherein measurements can be taken as a function of solar latitude, is the most important phase of the mission. Investigators are specifically interested in the portions when the probes will be above 70° solar latitude, north and south. The data obtained in this phase will, among other things, provide a better understanding of the dynamics of the Sun, interplanetary space, and perhaps even our own climate.

Murphy's Law of Space Science first collided with ISPM in 1980. Early that year, Carter's Fiscal Year (FY) 1981 budget cuts forced the launch date to slip from February 1983 to April 1985. This in turn caused a restructuring of some contracts already awarded, cost increases to NASA, and problems for ESA budgeting. Immediately following this, the House Appropriations HUD and Independent Agencies Subcommittee, chaired by Edward P. Boland (D-Mass.) voted to cancel ISPM altogether. This brought strong reaction from ESA member states, and in turn the US State Dept., the While House, and Congress itself. As a result of this storm of protest, ISPM was fully reinstated for a 1985 launch.

The Law struck again this February with Reagan's FY 1982 budget cuts. When faced with a $487 million cut from its $6.7 billion budget ($160 million from space science alone), NASA decided to kill the US ISPM spacecraft to maintain funding needed for

the higher priority Venus Orbiting Imaging Radar (VOIR), Space Telescope, and Galileo Jupiter probe. Enough money was left in the budget, however, to maintain our commitment to the support of the ESA probe. This includes its launch on a shuttle orbiter, the US experiments on the ESA spacecraft, flight operations support, and manufacture of the radioisotope thermal generator (RTG) that will power the ESA probe.

The cancellation of the US spacecraft would cause a catastrophic loss in the scientific value of the mission – "considerably more than 50%" said one ESA official. Three experiments unique to the US craft, including the CXX, would be totally lost. Also, the highly important component of simultaneous data taking to create three-dimensional analysis possibilities would be eliminated.

ESA, already committed to over $100 million in non-retrievable costs, once again reacted strongly. The agency marshalled the political forces of its member states to pressure the US into fully reinstating the spacecraft before the FY 1982 budget is finished. ESA Director, General Erik Quistgaard, who has already had to deal with several US vacillations on ISPM, said that the cancellation was "effected without consultation" with ESA and "was a unilateral breach of the memorandum of understanding between the two agencies." Another European spokesperson elaborated that, although the MOU contained an article stating that each agency's obligations were "subject to their respective funding procedure," ESA expected this to be exercised only if "NASA was going bankrupt or something as serious as that." ESA officials emphasized that ISPM "was chosen in preference to a number of other purely European missions because of the value ESA attached to transatlantic cooperation." They went on to say that a US cancellation "would be detrimental to future space cooperation between Europe and the United States."

Fearing that the US would not respond favorably to its demand for full reinstatement, ESA, in March, proposed a less-expensive alternative to the ISPM spacecraft. ESA could build a copy of their probe and sell it to NASA for $40 million. TRW quickly responded that it could build a simpler, "all-spin-stabilized" probe, eliminating the costly despun platform. This would cut $12 million from the present $132 million pricetag, which has risen from the original $80 million price, due to contract modifications and launch delays. Both options would involve the elimination of the only imaging equipment in the mission, the CXX, but the TRW probe would retain two NASA-unique experiments. ESA emphasized that they are still strongly in favor of full reinstatement, but that either alternative was better than no US-funded spacecraft at all.

As we all know, the wheels of government grind slowly, but at least they do grind. On June 3, in response to the European warnings and adverse reaction within the US, the Congressional Conference Committee on the FY 1981 Supplemental budget restored enough funds to keep ISPM alive. The committee acknowledged that the US should decide, once and for all, what option it will fund and then maintain "a firm commitment to support" that option in the future. To assist in the decision, the

committee requested the NAS to review ISPM, considering "the scientific merits and cost of all of the *two* spacecraft options" (italics mine). The NAS review panel will give its recommendations to the committee by September 11 of this year. This was viewed by ESA as a very positive sign that the US wishes to fulfill its obligations to ISPM. In any case, budgetary restrictions will probably force another slip in the launch date, to May 1986, something that would itself anger ESA if it didn't have larger problems.

On the industry side of the ledger, TRW has already had to cut their original staff of 100 ISPM workers by half but emphasizes that they are continuing with the project. As a result of the personnel cutback, however, the company now "does not require any increase in the FY 1982 Reagan budget to keep all options open," a TRW spokesperson commented, "We are essentially in a holding pattern until September 11."

A TRW study shows that factors such as inflation, loss of tax revenue, and extra support costs would place the net cost to the US of the "$40 million" European spacecraft at $75 million. This is opposed to a $90 million net pricetag for the original TRW spacecraft (after tax revenue has been subtracted), thus making the ESA probe option much less attractive. TRW also claims that its ISPM subcontractors would be hit hard by the cancellation. Other industry sources indicated that several small companies may be put out of business if the US spacecraft is cancelled. TRW, however, sees the "loss of the technology base from US industry" that an ISPM cancellation would cause as the most damaging loss. If the US probe is not built here, there will be "deleterious effects on the economy and competitive posture of US industry in future years," the spokesperson predicted.

While the NAS review panel is conducting its crucial study, everyone is waiting and stewing. ESA has made it clear that if the US does not fully reinstate this uniquely valuable mission, future space science cooperation would probably be damaged. Although it is unlikely that the ISPM troubles will totally kill future joint projects, it seems certain that next time around Europe will demand tighter commitments. Moreover, if the US gains the reputation of an "unreliable partner," as it has with ISPM, scientific cooperation in other areas with both European and non-European countries could be affected.

American industry would also be hurt by cancellation of the original ISPM package. Such "yo-yo" funding behavior, industry sources complain, is economically damaging and psychologically demoralizing to US companies. This point is hammered home even harder when one considers the prospect of a US agency buying a "high-tech" spacecraft from European rather than American corporations.

Some observers believe that this is just one more symptom of a pervasive problem in government funded project year to year budget fluxuations. The observers suggest that the government should begin funding space missions, and other projects of this type, all at once from the beginning, rather than in the present

piecemeal fashion. This would insure that once a contract is awarded, or a MOU signed, it would not be abrogated later.

In any case, the US government must strive to honor its commitments, both foreign and domestic, or Murphy's Law of Space Science is destined to devour other valuable space missions, and endanger the future of international cooperation.