NASA: Ranger Misfortunes Attract Attention of Congress to Problems of Spacecraft Sterilization

Reports that Congress these days is less moonstruck over the space program were given substance late last month when the House Science and Astronautics Committee recommended reductions of nearly a half billion dollars in the $5.7 billion requested by the National Aeronautics and Space Administration for operations in fiscal 1964.

In proportional terms, the heaviest cuts would fall on programs for unmanned spacecraft, which are being counted on to bear an increasingly heavy burden in obtaining scientific data from space. In addition, the subcommittee which deals with space sciences gave NASA some advice on the sterilization of spacecraft ticketed for lunar or planetary landings, thereby joining the debate over a complicated and, for scientists, very touchy subject.

The committee's attention was unquestionably drawn to the Ranger unmanned spacecraft program by Ranger's record of five failures in five tries in 1961 and 1962. Compared to the scientifically productive Mariner II flyby of Venus and a remarkable 100-percent record of success with satellites last year, Ranger has become rather the sore thumb of NASA's space sciences program.

Recommended by the committee is a reduction of $25 million in the $90 million asked for the Ranger program. (Ranger spacecraft in different versions are designed to take television pictures of the moon, perform experiments en route, and land instruments on the moon's surface.) The committee went on to urge denial this year of the entire $28.2 million sought for development of the Surveyor Orbiter spacecraft, a successor to Ranger that is intended to provide an extensive TV survey of the moon's surface.

In a report backing its recommendations, the space sciences subcommittee, chaired by Representative Joseph Karth (D.–Minn.), added some cutting words to the cut in funds, noting that the subcommittee voted to reduce funds "to indicate its lack of confidence in the Ranger project and to assure sufficient time for improvements to be made and incorporated in spacecraft [Rangers] Nos. 13 and 14 on which work has not yet begun."

The spirit that moved the House space committee to urge the biggest reductions in the space budget ever suggested seems to be compounded of three major elements: (i) an economizing impulse suffused through Congress apparently as a result of the administration's big-budget and tax-cut proposals; (ii) a harkening to the critics of the moon-landing program, who say that NASA is asking too much too soon; and (iii) a growing sophistication and confidence on the part of the committee that it has learned enough to undertake more active criticism of NASA programs.

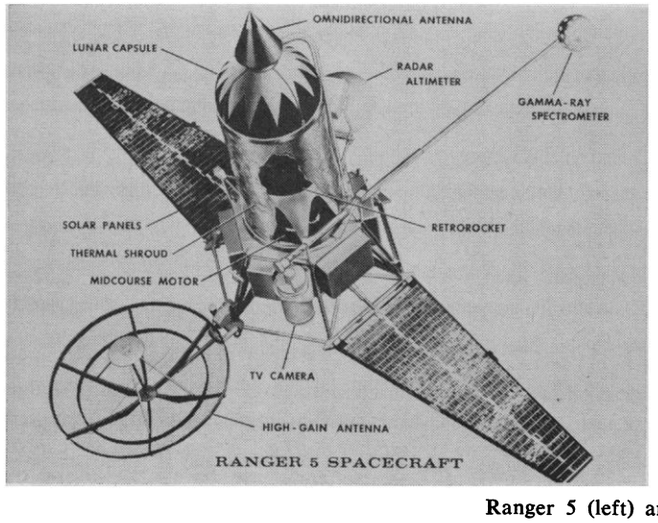
By accident or design, the recommended reductions total very nearly the half-billion-dollar figure that congressional insiders have bandied about as an estimate of the slice that Congress might cut from the space budget. The committee, however, clearly used pruning shears rather than a broadax in operating on the authorization bill

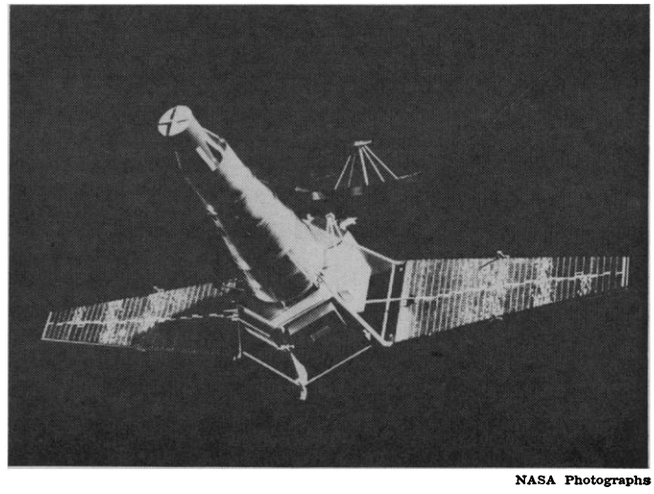
Rangers and Surveyors

Ill-fated Rangers 3, 4, and 5 each carried a vidicon camera, a gamma-ray spectrometer, a radar-ray reflectivity experiment, and a seismometer. The seismometer was contained in a capsule designed to separate from the spacecraft about 70,000 feet (21,350 meters) above the moon's surface and, slowed by retro-rockets and cushioned by a balsa-wood shell, land on the moon, turn an antenna toward the earth, and send information on seismic activity and meteoritic impact back for about 30 days.

Rangers 6 through 9 will feature a high-resolution television package designed to send back a large number of pictures before the spacecraft lands on the moon. A subsequent block of Ranger spacecraft, probably a series of six, would carry experiments similar to those on the first Rangers.

The next generation of unmanned spacecraft for lunar exploration is to be given the name Surveyor and will probably have both orbiting and "lander" versions. The latter Surveyors will be designed to make "soft landings" on the moon and will carry television cameras and instrumentation for extensive experiments on the lunar surface.





NASA Photographs

Ranger 5 (left) and Ranger 6 (right).

this year. While congressional committees have urged space-budget cuts before, these have usually been cuts cast in terms of percentage reductions of gross items rather than the sharpshooting, itemized cuts in specific programs put forward this year.

The half-billion-dollar figure is a little misleading since a substantial part of the funds which would be denied involves expenditures to be made in subsequent years or for programs which could be financed later without serious effect. In recommending the biggest reduction of all—$120 million of the $1.2 billion requested for the Apollo moon-landing spacecraft—the committee questioned whether NASA could really use so large a sum in one year.

It is, at any rate, too early to assume that the House committee's cuts will be fully applied. The Senate Aeronautical and Space Sciences Committee has not taken final action on the bill, floor action in both houses could change things, and the whole appropriations process still lies ahead. And there is always the question of what the Russians may do up yonder.

The House committee's action, nevertheless, can be taken as an earnest of congressional intentions to keep a tighter rein on NASA in the future. This year the new chairman of the Senate space committee, Senator Clinton Anderson (D.–N.M.) and his staff kept in close touch with their opposite numbers in the House and are well informed on what cuts were made by the House space committee under chairman George P. Miller (D.–Calif.), and why. For the first time, the right hand knows what the left hand is doing, and close observers feel that this exchange of information will make it likelier that the committees will act in concert.

The House committee's rough handling of Ranger certainly reflects a new militancy in judging NASA's plans and performance. The decision to recommend the Ranger cutbacks cannot have been taken lightly, since the project is regarded by NASA as providing the first direct steps toward a manned landing on the moon and is generally viewed as having important scientific value in its own right. The five straight failures not only embarrassed the space agency and frustrated the scientists who had worked hard on the Ranger experiments but also disappointed the scientific community at large.

The Ranger 1 and 2 launchings, in August and November of 1961, were not meant to be moon landings but were, in fact, test flights. As it happened, failures occurred both times in the Atlas-Agena combination, which is the launch vehicle for all the Rangers. There was some consolation, however, in the report that the spacecraft themselves operated well, even though they were not meant for the low earth orbits into which they were injected.

Ranger 3 suffered from troubles in the Atlas guidance system, which caused the spacecraft to miss the moon by 22,000 miles (35,000 km). Ranger 3 itself behaved well on the trip but failed to follow orders to take photographs as the space ship passed the moon.

In the last two Ranger shots the launch vehicles operated successfully. Ranger 4, however, suffered a primary kind of failure in the sequencer and control element, and though the spacecraft did hit the moon, it was dead on arrival. A power failure in Ranger 5 put the experiments aboard out of action, and the mission resulted in a near-miss of the moon.

Improving Reliability

Up to the time of the Ranger 5 shot, in November 1962, the Ranger program had been proceeding at a rate of about one shot every 3 months. Then, as one NASA official said, "We decided to fall back and regroup." In a statement before the House space committee, Homer E. Newell, director of NASA's Office of Space Sciences, put it this way.

"Guided by our experience in 1962, and by what has been learned by a thorough review of the Ranger situation, we are taking firm corrective measures in 1963. What would have been Ranger 6 has been taken out of the flight schedule for extensive ground testing and reliability improvement studies."

The Jet Propulsion Laboratory, in Pasadena, on offshoot of the California Institute of Technology, has been project manager for Ranger, and a rigorous review of the project was undertaken by a committee composed of people from J.P.L. and the Office of Space Sciences and headed by Albert C. Kelley, director of electronics and control in NASA's Office of Advanced Research and Technology.

The findings of this panel were available to the Karth subcommittee earlier this year, and the committee seems to have drawn on them heavily in making its recommendations on Ranger.

In its own report the subcommittee said, "The Kelley report indicated that the unreliability of the Ranger spacecraft to date is due, at least in part, to the sterilization procedures followed by the Jet Propulsion Laboratory. The subcommittee is mindful of the necessity for precautions to prevent contamination of other celestial bodies by the introduction of earth-spawned bacteria, but questions the wisdom of employing sterilization procedures which tend to damage sensitive equipment and reduce the reliability of spacecraft systems. Missions to explore the moon and other planets are costly experiments and the subcommittee desires the report which accompanies the authorization bill to urge NASA to make every effort to devise and utilize economic and effective sterilization procedures which do not endanger the success of such missions."

Contamination by nonsterile spacecraft has been a source of concern to scientists, and especially to biologists, since space probes and particularly lunar and planetary landings became feasible. Sterilization, however, constitutes a problem, since present means of sterilization—dry heat, bactericidal liquids or vapors, irradiation, filtration of liquids—are all suspected of degrading spacecraft components to a degree which significantly reduces the chances for successful missions.

One of the broadest general discussions of the problem available is to be found in the published report of the Space Science Summer Study, sponsored last year by NASA and the National Academy of Sciences at the State University of Iowa.

"The ultimate goal of the NASA spacecraft sterilization program," said the report, "is that biologically significant information about the Moon and planets shall not be compromised or destroyed. The exobiological organisms and biologically pertinent organic matter on these bodies may be subject to irrevocable change through contamination introduced by nonsterile space probes. The physics and geology, on the other hand, are not subject to change."

It is important, the scientists insisted, that the biological experiments be scheduled first, and that uncontaminated samples be collected, even if they are not analyzed until later.

As the list of Ranger failures lengthened, speculation among scientists outside the Ranger program centered on sterilization as a cause of failure. Some argued that lowering the sterilization standards would raise the

odds in favor of success and cited as prima facie evidence the flight past Venus of Mariner II, which was not designed for a landing and was not sterilized. They observed that sterilization of spacecraft destined for the moon seemed superfluous, since the scientific odds seemed to be heavily against earth microorganisms surviving in the hostile environment of the moon.

The critics could argue that neither Ranger 1 nor Ranger 2 had been heat-sterilized, that both had performed well, and that the Ranger design seemed sound, since so much of what had been learned from Ranger had been incorporated in the successful Mariner spacecraft.

Debate on the matter, however, has been hampered by the unavailability of the Kelley report. Because the report touches on aspects of the guidance system and launch vehicle which are classified information, the entire report has so far been kept under wraps, an instance of an exception to NASA's avowed policy of running an "open" program.

While the Karth subcommittee statement and the newspaper play of the story had the effect of making sterilization the chief culprit for the Ranger failures, NASA officials are generally more cautious about assigning blame.

As Oran W. Nicks, director of the lunar and planetary program, said, "It is obvious that sterilizing a spaceship with 19,000 parts is more difficult than sterilizing a surgeon's instruments or a can of tomatoes." And laboratory tests indicate that sterilization results in "artificial aging" of some components, says Nicks. But NASA has "no direct evidence" that sterilization caused the Ranger failures.

A Topic for Speculation

NASA officials follow the cautious line taken in the summer study: "There is some evidence that certain sterilization procedures reduce the reliability of spacecraft components: it has not yet been possible to carry out quantitative measurements of the degree of degradation, so the matter is still largely a topic for speculation."

But NASA seems, in fact, to have modified requirements for spacecraft sterilization. Jet Propulsion Laboratory sources say that Rangers 6 through 9 will not be heat-sterilized (the J.P.L. recommendation for dry heat treatment has been 135°C over 24 hours for planetary spacecraft). It is even unlikely that a bactericidal chemical will be pumped into the hood covering the spacecraft at the launch site for the purpose of "terminal sterilization", as has been done before. Faced with indications, however circumstantial, of sterilization-induced failure, the Ranger people seem to be taking no more chances with Ranger shots, which are scheduled to be resumed late this year.

NASA and nongovernment scientists agree that differing degrees of sterilization are required for different targets for scientific space probes and landings. The surface of Venus is apparently too hot, and temperatures on the moon seem to run too hot and cold, to support terrestrial organisms, although it has been argued that in protected places beneath the lunar surface microorganisms might be preserved.

Keeping Mars Clean

The case against pollution appears to be strongest for Mars. In the words of the summer study, Mars "is at present our most important exobiological objective. As a matter of national policy, it should be declared that the first several Mars missions will be principally, and if need be, exclusively, for biologically significant research."

NASA is committed to a policy of maximum sterilization on a spacecraft headed for Mars, and that policy, with its implications for the odds for success of the shot, will probably be put to the test when an opportunity for a Mars probe comes up next year.

While the Rangers' launch vehicle has not been directly implicated in the sterilization controversy, the Atlas-Agena vehicle was involved in three of the five failures, and there has been speculation that the vehicle was either unreliable or being handled by the junior varsity.

NASA officials deny both theories. In the posture hearings, NASA spokesmen noted that it takes time to work the bugs out of any new system. Newell testified that "experience in large military systems shows that it takes 20 firings to achieve a 50 percent success. Well, NASA is not going to be content with waiting for 20 Ranger firings to have a 50 percent success. However, at the present time we are about par for the course."

One advantage which NASA officials privately grant the manned-spaceflight program over the unmanned-spacecraft program in respect to launch vehicles is the carte blanche given Mercury Project officials to hand-pick components for launch vehicles from the assembly lines. The same basic Atlas rocket has been used for the Mercury and the Ranger projects, but because human life is at stake in a Mercury launch, an astronaut gets what amounts to a custom-built booster, whereas the unmanned spacecraft is lifted by a good but run-of-the-mill Atlas.

According to the Karth subcommittee, the Kelley report also "casts grave doubts on the adequacy of the management of this project, both by NASA headquarters and the Jet Propulsion Laboratory." Apparently the Kelley report carried sharp criticism of quality control and quality assurance procedures on Ranger.

One remedial step which has been taken follows a recommendation of the report that a commercial contractor be given a bigger role in Ranger management. The Nortronics division of the Northrop Corporation, which has been an important subcontractor on Ranger, will assist J.P.L. on design reviews and checkouts of the spacecraft and, if things go well, will eventually take over as project manager for the spacecraft, while J.P.L. retains overall management of the Ranger program. The aim will be to relieve J.P.L. of the production and routine tasks which have fallen to it as the number of Rangers increased and for which many familiar with the program feel that the research lab is not suited. The Jet Propulsion Laboratory itself a year ago officially requested that an outside contractor take over fabrication of the spacecraft.

One larger question raised by Ranger's troubles concerns the importance to the manned lunar landing progam of the information—or until now the lack of it—from the Rangers. The answers given by NASA officials do not convey a clear-cut impression, but the view seems to prevail that the lag in getting results will not have too serious an effect so long as future unmanned flights are more fruitful.

"The Apollo design is set on a pretty pessimistic view of the moon," says one NASA official. Scientists planning the lunar landing believe that they have a good idea of the general conditions that will be encountered, but "unmanned spacecraft will play an especially important role in search and confirmation of landing sites. If they can't find a place, then the [Apollo] design will have to be changed." If, in short, later Rangers and the Surveyors perform well and uncover no big surprises, the lunar landing program should not suffer.

—JOHN WALSH