



Mariner IV takes off for man's first close-up look at Mars.

In the exploration of space, the U.S. faces an inescapable choice:

TO LEAD OR TO FOLLOW

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space-related research, which includes making detailed infrared observations of the moon and planets.

Naturally, then, Bruce Murray has strong convictions about America's space programs—convictions most recently expressed before the House Subcommittee on Space Science and Applications in Washington, D.C., on February 20. (The full text of this statement appears on pages 13 and 14.) Back on the Caltech campus the next day, Dr. Murray faced questions from the press. On the following pages—some highlights from this interchange.

Caltech's Bruce Murray states the case for U.S. planetary exploration in an interview with a group of the country's top science writers.

To put it bluntly, the United States is in the process of going out of the business of space exploration, and 1968 is the year in which the patient is becoming terminal. I feel that there is a very real chance that your children and mine will grow up reading about the planets and other discoveries in space from Soviet news reports and Soviet books. And I personally find that a very dissatisfying feeling. I am accustomed to the American view of managing to maintain at least some excellence in areas as challenging as the discovery of new worlds.

Why is it dying? Who is responsible?

You. You, the American people. The space exploration program is not dying due to any Machiavellian plot; it is dying because the American people are fearful; they are turning inward. They are more concerned about the problems of the present than with the hopes of the future, and they are showing it very much in the kind of legislation that is getting passed and in the national priorities that are being set. The blame cannot be placed entirely upon Congress and the Administration because, if popular opinion polls had been followed, we would have gotten out of the space business a little sooner.

Are you more concerned with space exploration in 1978 than a Watts in 1968?

No. However, I am concerned about the image an American has of himself now and will have of himself in 1978. What kind of a person is he and what kind of a country, culture, and society does he represent? I think a country that has the capability of participating in something as exciting as space exploration and chooses not to do so is giving in to an undesirable aspect of its own self.

What evidence is there that the Russians are more concerned with the future in space than the U.S.?

The Soviets have now demonstrated a very

impressive interest and a capability for planetary exploration. They have launched or attempted to launch 19 spacecraft to Venus and Mars since 1960. These have included both landers and flybys, and until October 1967 they had not one single success. They've missed only one planetary opportunity, which was the last one to Mars, and I think there were strategic reasons for that. They kept up this effort even though there was a major change in their government. The technical character of their program is the same now as it was in 1960. The objectives have been, starting with Lunik II, to reach—physically reach—the surface of these cosmic bodies. Something in the Russian character is involved here; this is terribly important to them. If you read the Soviet domestic news reports written for Russians by Russians, you will realize this. They were first to get to the Moon, they were first to make a soft landing on the Moon, they were first to get to Venus, and it is obvious that they intend to be the first to get to Mars.

Isn't that just for political reasons?

No. I think their drive reflects a cultural motivation and is not "political" in the propaganda sense. It demonstrates to them the promise of their own society. They have suffered a very great deal. They have put up with a lot of things they don't like. When they are able to do something that they recognize as important and historic, and to be the first, this demonstrates to them that they are the wave of the future. They really feel this way. Our mistake in evaluating it is that we tend to be a little too cynical. We assume it is all a Madison Avenue stunt, and it is not. I think the Soviets would have the same planetary program now even if there were no way of communicating to the West what was going on. I think they would do it for domestic reasons. There is no other explanation for the magnitude of the planetary program. It represents an effort something like five or ten times as

large as ours, on a much smaller industrial base. There is no national justification for such an investment except that it is a very important program for domestic reasons.

It seems to me that what you are offering us is just one more chapter in "the Russians are coming, the Russians are coming." Isn't that just what we've reacted to in the last ten years?

Not in the planetary program we haven't. Not by a long shot. The Soviet effort in space is a much bigger one than ours. If we are so frightened, so fearful, and so unsure of ourselves in 1968 that we don't want to respond, I am very worried about us. The reason this is the kind of challenge we should respond to and take seriously is that it is a challenge to our culture's self image. It is not a challenge to national security. That's the point. If a nation only responds to external things that are security threats or only responds when there are riots in the streets, then it is a sad thing, and perhaps such a society won't last long unless it has something more redeeming and more enduring in its image of itself and as its purpose. This is why I say exploration in space is a cultural challenge—and a profound one.

How can our money be best used to give us a viable planetary space program?

The amount of money requested this year for the planetary program is, I believe, enough to support a continuing planetary program which will provide a spirit of adventure and discovery for America. Quite honestly. And it doesn't require that we have enormous funds in the future. It isn't just a come-on. But I don't feel this can be done if we also continue the present program aimed at the search for life on Mars. The U.S. has not faced squarely the choice between a good program it can afford and the much more expensive one that it would like to pursue.

Are you then advocating abandoning the search for life on Mars?

No, I'm advocating that Congress declare whether it is willing to fund the search for life on Mars. If Congress continues, as it has in the past, to support only a small effort and to pay verbal homage—saying "Wouldn't it be nice?" and "Shouldn't we have a big one?" and not do it—then we will have nothing.

Has the Administration made a clear decision not to continue the search for life on Mars?

The presently proposed program in front of Congress includes a Mars mission in 1969, a new proposed mission to Mars in 1971, and a new mission in 1973. Yet it still does not include a life-detection experiment on Mars. The principal justification for those missions evidently is to carry out the preliminary steps before life-detection. A more ambitious mission for life-detection could not be entertained before 1975 and then only if we are willing to provide sharply increased funds two years from now. Thus, it is not clear whether the U.S. will actually search for life on Mars in the 1970s at all. I doubt very much if the Soviets will find it necessary to take so many steps over so long a time scale. I expect the Soviets will go much quicker and go directly into a life-detection mission of some kind.

Couldn't the U.S. drop the preliminary missions and make an all-out effort to search for life on Mars?

I think the problem is not the life-detection mission per se but the lifetime of the lander once it has touched down. The proposed 1973-probe will live for only one day, and life-detection experiments are generally those testing some kind of growth. You throw something out and see if something eats it, or in a very sophisticated way find out if it's growing. If technological considerations alone were all that were involved and a realistic appraisal of the sterilization were made in conjunction with what the Soviets have already indicated, there is no question in my mind that we could deploy a life-detection experiment on the surface of Mars in 1973; and that we could deploy an important precursor in 1971. That's not a technological question, and frankly I don't think it ever has been. It's tied in to some ghosts that have inhabited some dark regions of our decision making.

If we take the "Grand Tour" as opposed to searching for life on Mars, won't we just have a little bit of information about a number of planets rather than a firm grasp on one?

This is a strategic decision, and I did not say we should do that. I said that we must be rational in our choice, and if we accept the challenge of the search for life on Mars, recognizing Soviet competition in this area, we must

be sure that we accept the cost implications for future years. But if the U.S. in its wisdom decided it preferred a less costly alternative strategy, I would suggest this logic: We can know so little about the other planets because of their distance from the earth and because of the limitations of our atmosphere that a flyby can give us significant information about those planets by returning high-resolution photographs and other close-up measurements, such as information about magnetic fields and radiation belts. Such "first looks" represent an enormous intellectual step, and one that must be taken in any discovery program. In this approach, one doesn't make a priori decisions about one planet being the most interesting before preliminary information has been obtained about others. Rather, one should take a first look at as many planets as possible and then decide where to concentrate the obviously expensive direct measurement phase.

What do you think are the five or six next planetary programs which the U.S. could consider?

I will give you some possible programs in the order in which we can do them. Our alternatives would be dependent on timing.

In 1970—a first look at Mercury, which up to this time has not been photographed due to its nearness to the sun. In going to Mercury, we could get a free look at Venus and perhaps discover if photographs are a useful way to explore it close up; the continuous cloud cover has prevented us from seeing the surface. We are so ignorant about many of these planets that no matter what we find it can't help but be significant. We can't lose, and this trip would have a big impact on our total view.

Beginning in 1972, we will be able to go to Jupiter every 14 months. We must develop specialized electrical power sources to do this, however—sources that can stand getting that far away from the sun. This is not a big deal, but we've got to get it ready. If it's not ready, we can't go. In a trip to Jupiter we could find out about its radio emissions and how its radiation belts affect them as well as learning about some of the "fine structure" in its clouds.

In 1977-78, we can handle the "Grand Tour." This is a mission where a spacecraft is launched to Jupiter; there it is captured, and then it escapes from Jupiter's gravitational field and is

accelerated out into the distant ranges of the solar system where we could never go by chemical or even nuclear rockets, at least not in the near future. This is the same trick that is used to get to Mercury, but with Jupiter being so massive it really provides a zap! The "Grand Tour" would go by Jupiter, Saturn, then by Uranus, and finally on to Neptune, the whole thing taking about ten years. The next time this "Grand Tour" will be possible is 2153 A.D.! For a major power that has the technical capability not to take advantage of this, not to exploit this fantastic opportunity, would be inconceivable. I realize that is a strong statement, but I feel very strongly about this.

Why haven't we heard much about this "Grand Tour"?

This whole set of missions depends upon gravitational acceleration by one planet to another. The so-called swing-by missions were just "invented," if you will, about three or four years ago, and this was a new, imaginative idea that opened up whole new realms of the solar system to exploration. That's one reason those missions weren't in the program before—people didn't even know about them.

Has enough money been appropriated for a significant space program this year?

The issue here is not whether the funds this year are sufficient. The issue is—what are the implications of future costs? If those future costs are not borne, what are the implications of the present program? The U.S. has come to a point in time where we really have some options. We have the chance to really advance. We must think of the cultural significance of what we have before us.

In your address before the subcommittee you stated that one of the compensations for living under the mental and moral stresses that characterize the wealthiest and most powerful country on earth is to be able to harness our wealth and power for the accomplishment of lasting events of which we are proud. What kind of events do you have in mind other than the space program, or is that the only one you would put in this category?

There *are* other events. I think there are very few, however, for which we have the current capability and that are so dramatic as the ones that I have described. You come to a point in

time when you have some options. You have the chance to really hit a home run as a country, and I think this is our chance.

Is the space program the only place where we now have the opportunity to hit this home run?

No, but I think it's the only place I know of where it is as clean-cut and simple. I'm sure if we can somehow make a major breakthrough

in the problems of helping underdeveloped countries gain scientific competence, that would be very important, but I don't see any simple way of doing that. I'm sure there are ways we can reduce the hostility and dissatisfaction of some of the urban areas, and this would be a great step forward. I don't know how to do that; I *do* know how to get to Mercury.

U.S. PLANETARY DECISIONS IN 1968—A TEST OF NATIONAL JUDGMENT

A personal evaluation of proposed programs for U.S. participation in planetary exploration, prepared at the invitation of the House Subcommittee on Space Science and Applications for presentation on February 20, 1968.

by Bruce Murray

As a nation we seem to be facing an inescapable choice as to whether to lead or to follow in the exploration of the solar system. I would like to clarify why, as a scientist, I think this is so and why, as a citizen, I feel it would be tragic if we were to ignore the challenge and the opportunity when it is within our means to respond.

The process of discovery, geographic and otherwise, is a basic human activity and particularly characteristic of Western civilization. Since the fundamental product of discovery is new knowledge, there is intrinsic significance to the first time an important observation is accomplished and enunciated. Subsequent repetitions of the observation are necessary to confirm and elaborate the basic discovery but do not have the same significance. Consequently, once there is more than one group of people with the technological capability for discovery, a competitive situation automatically exists. And, like competition in business, athletics, and other human endeavors, either a "race" between relatively equal participants results, or one group entirely dominates the situation.

In the area of planetary exploration, the U.S. has not been effectively challenged until last October. True, the Soviets have expended a much greater effort than we as evidenced by the fact they have attempted to launch nearly 20 large planetary spacecraft since 1960, including both landers and photographic fly-by's, while the U.S. has only attempted five smaller fly-by's involving less than 2 percent of the NASA budget. Yet, the cultural and scientific rewards have, until now, gone entirely to the U.S. The Mariner II flight to Venus in 1962 was man's first direct venture outside of the Earth-Moon system and discovered that our nearest planetary neighbor had no magnetic field. Most important, it pioneered the technological tools necessary to subsequent discovery. Those tools were brilliantly utilized by Mariner IV when it discovered

in 1965 that Mars' surface resembled that of the Moon rather than the Earth, that its atmosphere was thinner and more hostile than has been supposed, and that it too did not exhibit magnetism.

Then, last October, the veil of mystery surrounding Venus was pierced directly for the first time by the Soviet capsule mission Venus IV. Suddenly our Mariner V mission lost all chance of being a mission of discovery and was relegated to the role of filling in some of the details. Suddenly, there was another group of people with the technological capability for discovery, and thus a competitive situation came into being. Suddenly, U.S. scientists began to recognize that they might learn about the surface conditions and atmospheric composition of Mars also through Soviet news reports rather than as a result of their own efforts, and further that they might have very little to say about what precautions should be taken to prevent accidental contamination of that planet.

Of course, just because the Soviets have demonstrated a new space capability doesn't necessarily mean they will aggressively utilize it; obviously the U.S. shouldn't attempt to respond to every *possible* Soviet challenge. However, the Soviets have stuck to their original planetary objectives through seven years of disappointing failures and a major change of government even though the U.S. was achieving great success with a much smaller program. And it would be a mistake to attribute such intense and undeviating effort solely to expected propaganda benefits. Venus IV was a very sophisticated scientific endeavor as well as a major technological achievement. Even a casual perusal of the Soviet reporting of Venus IV cannot leave much doubt that being first to the Moon and now to Venus with an unmanned landing constitutes a very meaningful demonstration to the Soviet people of the technological and cultural potential of their own society. There is every reason to expect the Soviets to

aggressively exploit their newly demonstrated space capability in an attempt to place a scientific instrument package on the surface of Mars along with the usual Soviet pennant. And there is no evidence they regard the search for life on that planet necessarily as such a complex and difficult task that it must always await second or third generation landers. They might even begin initial experiments with a first landing as early as 1969.

Hence, it seems to me that we must accept the real possibility of Soviet Mars lander attempts as early as 1969 and that we cannot rule out other attempts at planetary firsts either. The real question, then, is what alternatives do we have to participate in the exploration of our planetary companions in this lonely solar system? Most important, do we care enough to make the effort? Is it really very important to us whether or not America plays a key role in what must be regarded as one of the great human endeavors of this century?

1. The recent Soviet Venus success abruptly ended any unilateral U.S. view of planetary exploration objectives and schedules. From now on, we must take into account probable Soviet endeavors when committing our own resources for planetary exploration.

2. Because of our present superiority in communications, in spacecraft reliability, and in photography and other kinds of remote sensing instrumentation, we can maintain a position of unchallenged excellence in some aspects of planetary exploration by pursuing opportunities for a 1970 Mercury flyby, for an early Jupiter flyby (launched no later than 1973), and for a 1971 Mars orbiter. These missions, together with early preparations to exploit the once-in-a-century opportunity in 1977-78 to take the "Grand Tour" of Jupiter, Saturn, Uranus, and Neptune, can be carried out without national commitment to major funding increases in future years.

3. However, the Space Science Board of the National Academy of Sciences has recommended that the search for evidence of simple life on Mars be the principal objective of the U.S. planetary program. A large, urgent, and concentrated effort now will be required if we still wish to participate in this exciting venture. In particular, postponement until 1973 of the first U.S. landing effort on Mars incurs a high risk of obsolescence for that mission as a result of equivalent or superior Soviet landings in 1969 or 1971.

4. On the basis of the foregoing, the currently proposed planetary program may be regarded as an inadequate compromise between the opportunity to exploit our strength in flyby's and orbiters on the one hand, and the need to develop a competitive lander capability on the other. More satisfactory alternatives might include a single Mars lander mission in 1971, perhaps with an orbiter launched separately also, or a single-launch to Mercury by way of Venus in 1970 at the expense of some of the Mars effort currently proposed.

5. The present compromise is, however, only a symptom of a more basic weakness in our national

space effort—the lack of agreement as to its character and magnitude in the post-Apollo period. We can have a program of planetary exploration at modest cost by emphasizing "first looks" at ever more distant planets. We can also participate in the direct exploration of the surface of Mars, if we are willing to substantially increase available funds each year for the next three to four years. But the sure road to mediocrity and to a conspicuous second place, now that the Soviets are in the game, is to try to keep both options open within limited resources. Congress, NASA, and other elements of the Government must come to terms on whether or not funds for U.S. planetary exploration can be expected to increase rapidly in the coming years. The enormous disparity between proposed and actual funding must end if we are to effectively pursue *any* planetary program of distinction.

6. If the enthusiasm of the American people is judged insufficient to support rapid increase of funds for planetary exploration, then we must realistically reexamine the search for possible microbial life on Mars as our guiding strategy, perhaps to conclude that we had best wait initial Soviet results on that subject while pursuing effectively other very challenging scientific objectives in space. There simply may not be now, nor ever have been, life on Mars, whereas the first close-up looks at Mercury and Jupiter, to say nothing of the more distant planets, will surely be historic milestones in man's search to understand his surroundings. We need not always be first but must not always be second.

The U.S. is faced with many challenges today. Some, like the Soviet nuclear capability, bring into jeopardy our very survival. Others, like the increase in domestic violence and lawlessness, put us on notice that we must more effectively adapt our social attitudes and procedures to the ever increasing pressures of the Industrial Revolution merely to sustain the quality of American life, much less enhance it. But beyond challenge to our security and welfare there is the challenge to excel as a society, to contribute significantly to the history of man. That is the nature of the challenge of planetary exploration. This challenge can't be postponed—the planets are going to be explored only once in this history of man, and that time is close at hand. One of the rewards for living in this chaotic 20th century is to witness such marvelous events. One of the compensations for living under the mental and moral stresses that characterize the wealthiest and most powerful country on earth is to be able to harness our wealth and power for the accomplishment of lasting events of which we are proud. We must not fail to respond, because it is a challenge to our vision, to our optimism for the future, to our image of ourselves.

Congress can and must insure that the next generation of Americans can share with us genuine satisfaction and pride in their country's spirit of adventure and discovery. A national commitment to excel in at least some phases of planetary exploration is necessary in 1968 if this precious part of our heritage and national character is to be sustained.