SPACE SCIENCE BOARD
National Academy of Sciences
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Statement by

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before the
Committee on Aeronautical and Space Sciences
U. S. Senate

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Mr. Chairman: I am always happy to appear before this Committee though on this occasion I do so somewhat breathlessly having flown here from Venezuela preparing a statement for you while enroute. Consequently, the statement is not the polished document I would like it to be but it does, I believe, present accurately the facts and opinions which I wished to convey.

Role and Activities of the Space Science Board

Dr. Berkner, representing the National Academy of Sciences, has already told you something of the history and role played by the Space Science Board. As its current Chairman I would like to add to Dr. Berkner's statement something about its recent functions and more important activities since I last came before this Committee in 1963.

The Board ordinarily has about 15 members chosen by the Academy from among the nation's outstanding scientists. These men represent a variety of disciplines - Physics, Chemistry, Astronomy, Biology and Medicine, Atmospheric Sciences, Geology, Engineering, etc. I doubt if any one of them would refer to himself as a "space scientist" though the majority are engaged in some form of research within the very large area of Space Research.

The Board works through ad hoc committees - e.g. currently Exobiology, Astronomy, Lunar and Planetary Sciences, International Relations, NASA-University Relations, etc., involving about one hundred experts - scientists, engineers, medical doctors and administrators - recruited from universities, government agencies and industry.

While our mission is to advise all government agencies involved in the Space Program naturally the bulk of our effort is devoted to

NASA. A comparatively small effort has gone into advice to DOD but we are currently trying to increase our relationships with the Air Force. We have had most cordial and I believe beneficial relationships with the Astrogeology Branch of the U. S. Geological Survey (Department of the Interior) headed by Dr. Eugene Shoemaker.

Formal meetings of the Board are scheduled at about four month intervals but its committee activities go on continuously. Nevertheless, it is an almost insuperable task to keep up to date on day-to-day problems and activities of so large and varied an operation as NASA's. In order to surmount this difficulty one or more members of the Board serve on each of NASA's internal scientific committees. For example, two serve on Homer Newell's Planetology Subcommittee and three on George Mueller's Science and Technology Advisory Committee. In this manner a close working relationship is maintained between the Board and NASA.

National Goals in Space, 1971-1985 (October 30, 1964)

I assume from your letter to Dr. Seitz, Senator Anderson, that the matter of formulation of plans for space programs following Apollo is uppermost in your Committee's deliberations at the present time. At the request of Mr. Webb, Administrator of NASA, last fall the Space Science Board prepared a document dealing in a broad general way with goals for the period to 1985. This document is Appendix 4 to Dr. Berkner's report. Long-range planning has been probably the most important activity of the Board for the past two years.

The broad goals suggested in the October 30, 1964 report are being supplemented by much more detailed reports growing out of the Summer Study just completed at Woods Hole. Dr. MacDonald has reported to you the findings of the Lunar and Planetary Exploration Committee, which is the most pertinent of the nine committee reports completed this summer to the present hearings. We hope to have the entire Summer Study report ready for approval of the Board by October and will be happy to make copies available to the Committee.

I might quote directly here the recommendations of our October 30 report:

> "Aware of the parallel criteria of scientific and intellectual importance and of significance to the national interest, the Board summarizes its recommendations on the primary national objectives in the field of space science for the 1971-1985 period as follows:
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> "1. Exploration of the planets with particular emphasis on Mars.
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> (a) This objective includes both physical and biological investigations, and especially the search for extra-terrestrial life.

" (b) The experimentation should be carried out largely by unmanned vehicles while the solution of difficult biomedical and bioengineering problems proceeds at a measured pace so that toward the end of this epoch (1985) we shall be ready for manned planetary exploration.

(c) Alternatives to the Mars and planetary exploration goal - (i) extensive manned lunar exploration (possibly including lunar base construction) and (ii) major manned orbiting space station and laboratory program - are not regarded as primary goals, because they have less scientific significance. However, both have sufficient merit to warrant parallel programs but of lower priority.

"2. An enhanced effort in basic astrophysical research aimed toward a better insight into the fundamental nature of matter and energy.

Particular attention should be paid to observations in the far ultraviolet and long radio wavelengths and in the X-ray and gamma-ray wavelengths because fundamental relationships might be discovered between the physics of the very large (relativity) and the physics of the very small (elementary particles). Attempts to observe gravitational radiation should also be supported and encouraged.

"3. Continuing pursuit of other physical, astronomical, and biological investigations on a broad scientific front using sounding rockets, earth satellites, space probes, lunar orbiters, and lunar landers.

"4. Continuing development of technical applications of space technology in the fields of communication, meteorology, geodesy, and navigation.

(a) Such work should be concentrated on basic technological development and on engineering demonstrations, but

(b) routine operational use of space systems in these fields should generally not be undertaken by NASA; instead, it should be assigned to the appropriate operating agency of the government or, as feasible, to private corporations."

I asked Dr. MacDonald this summer to direct his Committee's attention to arranging in order of priority experimental programs which might be carried out on each of the bodies of the solar system during the next 20 years. The priority was to be based on scientific return to be expected with due regard both to feasibility and timeliness.

This has been done and I believe will be a most useful guide for NASA. The only change from our October 30, 1964 position was to give a somewhat higher priority to Venus but leaving Mars as the number one objective. The committee arrived at its priorities by consideration for how investigation of each of the solar system bodies might contribute to (1) the search for extraterrestrial life (or the chemical systems which might be the progenitors of such life); (2) how much each body might contribute to the understanding of the origin and evolution of the solar system; and (3) how the information on each might contribute to a better understanding of the history, evolution and processes operating on our own planet, Earth.

There is not time here to consider Summer Study reports on a variety of other fields - Fundamental Biology, Biomedicine, Astronomy, Fundamental Physical Experiments, Rocket and Satellite Research, etc. Most important perhaps is that dealing with astronomy because the topic of non-ground based astronomy was specifically not covered in the Whitford Report, nor were solar system problems, which are of prime importance to the space program, an area pertinent to that particular study.

Exobiology Summer Study, 1964

Recognizing that probably the most important discovery which could be made in Space during this generation would be life or the progenitors of life on another solar system body, in parallel with our 1964 study of goals to 1985 we instituted an Exobiology Summer Study at Stanford University under the co-chairmanship of Professor J. Lederberg and Professor C. S. Pittendrigh. The summary of this study is attached as an appendix to this report. A volume giving the detailed conclusions and recommendations is currently in press.

Comment on Mariner IV Results

The magnificent achievements of Mariner IV are a source of gratification to all of us. However I would like to counter to some extent the emphasis which appeared abundantly in the press that it is a "lifeless" planet. The conditions on Mars with respect to life so far as they have been clarified by Mariner IV do not differ substantially from the assumptions made in the Exobiology Summer Study. I quote below a letter from Dr. Lederberg:

> "The Mariner photographs are very exciting but so far they have solidified previous expectations. They have not introduced new elements into the discussion that were not taken account of in previous deliberations.
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> "The main point to stress is that we still do not know the abundance and distribution of water on Mars. However

" much there is, almost all of it must be frozen, and this makes it very difficult to decide between a vanishing layer of hoarfrost at the poles and a thick planetary crust of permafrost under a sunbaked surface. In either case, we have the likelihood of scattered oases with local conditions far more congenial to life than the average for the planet. After all, too obtuse a view of the earth would have us all submerged in a thousand fathoms of salt water. Already, the most exciting aspect of the Mariner pictures is indeed the great variety of surface detail that they do show, including bright patches on some craters suggesting frost.

"There are many other questions that need far deeper study before any sweeping conclusions are justified. While I doubt that Mars has ever had extensive oceans, it is too early to assert this as settled fact. However, more likely almost all of its water has been frozen for most of its history.

"The swing of general opinion about Mars has undoubtedly been over-colored by lurid fantasies of canal-building humanoids which have played no part in serious scientific analysis. Now that these have been happily relegated to their proper place in imaginative fiction, our study of the solar system can focus on rigorous factual questions which continue to have the deepest scientific and philosophical interest. Paramount among these is whether life in any form has evolved independently of the terrestrial system and man."

In the past year the possibilities for life on Venus have been given more consideration. Assuming the unfavorable 600°F surface temperature (though this conclusion should be checked by further observations and by a probe when such an experiment can be undertaken), life in the dense atmosphere seems well worthy of investigation. After all on our own planet, fish, plankton of many sorts, and even mammals live suspended in our oceans. Why not life on Venus suspended in its atmosphere?

Scientist-Astronauts

The problems related to scientist-astronauts were not mentioned in Senator Anderson's letter but this was a topic in which the Committee seemed to have a deep interest in previous hearings. This year some four hundred application forms were completed. Those which passed preliminary screening were forwarded to the Space Science Board Selection Committee for examination of their professional qualifications as scientists or medical doctors. Sixteen were certified by us as having the outstanding qualifications deemed necessary for this important task. Five of the sixteen passed rigorous tests by NASA for other necessary qualifications. These have now been inducted by NASA and are in training.

The Space Science Board's Committee feels some concern over the future of this group of astronauts and others to be inducted in subsequent years. There is, we believe, a serious but not insurmountable problem in maintaining their proficiency as scientists in the years during and after their training. Some means must be found to schedule their time and endeavors so that they can actively continue research in their chosen fields and continue their careers as scientists. If this is not done future recruitment of highly qualified men may become difficult and possibly dropouts may occur among the small group now in training.