REVIEW OF THE SPACE PROGRAM

HEARINGS

BEFORE THE

COMMITTEE ON SCIENCE AND ASTRONAUTICS U.S. HOUSE OF REPRESENTATIVES

EIGHTY-SIXTH CONGRESS

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REVIEW OF THE SPACE PROGRAM

TUESDAY, FEBRUARY 23, 1960

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
Washington, D.C.

The committee met at 10 a.m., Hon. Overton Brooks (chairman) presiding.

The CHAIRMAN. The committee will please come to order.

This morning I might say to the members of the committee that we are pleased to have our newest member, Mr. Tom Morris of New Mexico, who has been selected to take the place on this committee and succeed our able colleague, Mr. Hall. So we welcome you this morning. We have a lot of work for you and all the members of the committee and hope you have a lot of time to put in and a lot of energy to put into the affairs of this committee.

If I were from California or Florida, which I am not, I would say this is the fastest growing committee in the Congress. But I still say it is a good committee and we are happy to have you.

Mr. MORRIS. Will the chairman yield?

The CHAIRMAN. Yes.

Mr. MORRIS. Mr. Chairman, I just want to say it is a real pleasure and an honor to be assigned to this committee and to be associated with the gentlemen who have worked so hard on this very important question that this committee has jurisdiction over.

It is a real pleasure for me to be here.

The CHAIRMAN. Thank you, Mr. Morris. The gentleman who just came in there and to your right is Mr. Roush. Well, we are happy to have you.

As we near the end of the general posture hearings on space and missiles, we are able to record that the committee has heard from most of the top officials, both civilian and in uniform, who carry responsibility for national progress in these fields. This has been useful to the committee for the report it will make to the Congress, in due course, and we believe it has been useful to the American public, with the help of the press representatives who have covered these hearings, and they have been unusually faithful in that respect.

This morning we are holding a session I view as an important addition to our consideration of these vital problems. The committee has invited the major technical societies and other groups concerned with space and missiles to present their views for the record. We hope at an appropriate time late to hear from industry as well as to round out these hearings in full.

The societies which are represented here today in combination have tens of thousands of members, resident in all the States of the Union.

Their members include close to 100 percent of all the technical talent in the Nation of those concerned with the space effort. Therefore, the views they are going to present to use deserve to be listened to with profound respect by the members of the committee.

My thought is that we will ask each witness to give an oral statement about 10 minutes in length, and to file any longer written statement for inclusion in the record. After this, the members of the committee may ask them questions, as a panel.

I say that because we do have Congress meeting at noon and we have our subcommittees, three subcommittees ready to report. We are going to take those reports up Thursday. We hope by that time that all four will be ready to report to the full committee. We will take those up Thursday. We will look them over in connection with the bill that we are writing.

So tomorrow we will meet at 9:30 in the morning to hear one additional witness who was invited for our posture hearings and who could only be here tomorrow morning. We are meeting early so as to give the morning to the subcommittees to finish up their work.

Mr. MILLER. Subcommittee No. 1, Mr. Chairman, must have an executive meeting. It finished all of its hearings and is ready to mark up the bill.

The CHAIRMAN. You can do that this afternoon or tomorrow. It will be all right.

Mr. MILLER. We have a meeting set for this afternoon at 2 o'clock in my office.

The CHAIRMAN. I want to commend the subcommittees for diligence. They have really gone to work earnestly, sincerely, and vigorously. As I just mentioned, three of them are about ready to report, and Mr. Sisk's subcommittee, I am sure, will be ready very soon thereafter.

Mr. FULTON. Mr. Chairman.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. May I say we are glad to have the societies represented here, but they are better than I expected. If, as the chairman said, they represent more than 100 percent of the technical people connected with the space program, they are doing very well.

The CHAIRMAN. I said close to 100 percent. [Laughter.]

Anyway, 100 percent is good enough.

Mr. FULTON. The other serious point I wanted to make, which is the reason I asked for the minute, I would like to ask Mr. Anfuso, and Mr. King, through the chairman of the committee, that the Science and Astronautics Committee ask the NASA people to come up with a statement of the use of scientific manpower in the agency; that is, whether they are adequately being used for scientific purposes; whether there might be a diversion of their use to management or to survey purposes; and whether there is any topheaviness in the executive end of the agency, so that there may be too many scientists or too many managers.

The CHAIRMAN. The Chair is going to rule that that is a subcommittee matter. Until the subcommittee reports, it will have to be handled by the subcommittee.

Mr. ANFUSO. This afternoon that will be taken up. I will discuss it with you later.

The CHAIRMAN. The first witness this morning is Dr. Howard S. Seifert, president of the American Rocket Society. His biography has been placed before each member. He is also a senior staff engineer of Space Technology Laboratories and is the editor of the outstanding book issued last year called "Space Technology." He will present the statement of the American Rocket Society.

Dr. Seifert, we are happy to have you this morning. If you will proceed for about 10 minutes orally, we will file your statement and be glad to have you.

[From "American Men of Science," vol. I]

BIOGRAPHY OF DR. HOWARD STANLEY SEIFERT

SEIFERT, DR. HOWARD STANLEY, 382 S. Grand Oaks Ave., Pasadena 10, Calif. Physics: Reynoldsville, Pa., Feb. 17, 11; m. 33; c.3. B.S. Carnegie Inst. Tech, 32, M.S. 34; fellow, Calif. Inst. Tech. 34–37, Ph.D (physics), 38. Teacher, high sch, Pa, 32–34; asst. prof. physics, Kalamazoo Col, 34–40; research physicist, Westinghouse Elec. & Mfg. Co, 40–42; asst. proj. engineer and later chief liquid rocket sect, jet propulsion lab, Calif. Inst. Tech, 42–46, chief applied physics div, 46–51, staff engineer, 51–54; mem. research staff, Ramo Wooldridge Co, 54–[1]. Lecturer, Carnegie Inst. Tech, 42; U.S. Army Air Force premeterol. sch, Pomona Col, 43; Calif. Inst. Tech, 45–48. Tech. specialist, rocket ord. to Mil. Attache, London, 44. Asn. Physics Teachers; Rocket Soc. (assoc. ed, 'Jour,' 51–54). Liquid rocket motor design; missile systems.

(The statement referred to is as follows:)

TEXT OF STATEMENT ON AMERICAN ROCKET SOCIETY VIEWS OF U.S. NATIONAL SPACE PROGRAM

Made by Dr. Howard S. Seifert, president, American Rocket Society, before the House Committee on Science and Astronautics, February 23, 1960

I. THE AMERICAN ROCKET SOCIETY

Founded 30 years ago, the American Rocket Society is a professional society of approximately 15,000 engineers and scientists organized in 53 sections throughout the Nation. Its objectives are to foster and encourage the development of those sciences which relate to travel through interplanetary space; i.e., astronautics.

The areas of interest of the society are indicated by the following grouping of its 22 technical committees:

A. Flight Dynamics and Control:
   1. Astrodynamics.
   2. Guidance and Navigation.
   3. Communications.

B. Vehicle Design and Operation:
   4. Missiles and Space Vehicles.
   5. Structures and Materials.
   6. Power Systems.
   7. Test Facilities and Support Equipment.
   8. Logistics and Operations.
   9. Instrumentation and Control.

C. Propulsion:
   10. Propellants and Combustion.
   11. Liquid Rockets.
   12. Solid Rockets.
   13. Nuclear Propulsion.
   14. Ion and Plasma Propulsion.
   15. Ramjets.
   16. Underwater Propulsion.

[1] Now Senior Staff Engineer, Space Technology Laboratories.

COMMITTEE NOTE.—Dr. Seifert is President of the American Rocket Society, 500 Fifth Ave., New York 36, N.Y.

D. Fundamental Science:
   17. Physics of Atmosphere and Space.
   18. Hypersonics.
   19. Magnetohydrodynamics.
E. General:
   20. Education.
   21. Human Factors and Bioastronautics.
   22. Space Law and Sociology.

The name of the official society magazine was Astronautics during the 13 years from 1932 to 1945, and was changed to "Journal of the American Rocket Society" for most of the ensuing 15 years. At present two magazines are published, an archive-type Journal of the American Rocket Society and a semitechnical monthly called Astronautics.

The objectives of the society are accomplished by publication of these journals and by the conduct of numerous general and specialized meetings as well as by a number of other activities. For example, in 1957, prior to Sputnik, the society tendered a resolution to the President, urging the acceleration of space research. During the year 1960, approximately 10 general and specialist meetings will be held in addition to nearly 400 local section meetings.

The officers of the society consist of a president, vice president, permanent secretariat, and a 15-man board of directors, among whom are numbered many prominent contributors to the field of astronautics. The officers and directors comprise seven research directors, five vice presidents, and five engineering professors, all from major corporations or universities. Several of these men have testified or will testify before this committee as individuals. The officers and directors with their titles and affiliations are listed below:

Dr. Howard S. Seifert, president, ARS, special assistant to the executive vice president; professional development; Space Technology Laboratories, Inc.; visiting professor of engineering, UCLA.
Dr. Harold W. Ritchey, vice president, ARS, vice president, Rocket Division, Thiokol Chemical Corp.
Mr. James J. Harford, executive secretary, American Rocket Society.
Mr. Irwin Hersey, director of publications, American Rocket Society.
Dr. Ali Bulent Cambel, professor and chairman, Gas Dynamics Laboratory, Northwestern University.
Mr. Richard B. Canright, chief, Research Section, Douglas Aircraft Co.
Mr. James R. Dempsey, vice president and manager, Convair-Astronautics.
Dr. Herbert Friedman, Superintendent, Atmosphere and Astro Division, U.S. Naval Research Laboratory.
Dr. Robert A. Gross, Physics Department, University of California (formerly, chief research engineer, Fairchild Engineering Corp.)
Mr. Samuel K. Hoffman, vice president and general manager, Rocketdyne, a division of North American Aviation, Inc.
Dr. A. K. Oppenheim, professor of aeronautical science, University of California.
Dr. William H. Pickering, director, Jet Propulsion Laboratory.
Dr. Simon Ramo, executive vice president, Thompson Ramo Wooldridge, Inc.
Mr. William L. Rogers, vice president, Azusa Operations, Aerojet-General Corp.
Lt. Col. David G. Simons, chief, Department of Bioastronautics, School of Aviation Medicine, U.S. Air Force.
Mr. John L. Sloop, Chief, Rocket Systems Branch, National Aeronautics and Space Administration.
Dr. Martin L. Summerfield, editor, ARS Journal, Department of Aeronautical Engineering, Princeton University.
Dr. Wernher von Braun, Director, Development Operations Division, Army Ballistic Missile Agency.
Dr. Maurice J. Zucrow, professor of gas turbines and jet propulsion, Purdue University.

The immediate past president of the American Rocket Society was Col. John P. Stapp, chief, Aero Medical Laboratory, Wright-Patterson Air Force Base; his predecessor was Mr. George P. Sutton, presently chief scientist of ARPA and formerly Hunsaker professor of aeronautics at Massachusetts Institute of Technology.

II. THE SOCIETY'S VIEWS

In response to a request by the House Committee on Science and Astronautics to the president of the American Rocket Society, the members of the American Rocket Society's board of directors (listed above) were polled for their views on the adequacy of America's current space program. Two members abstained. A summary of the views received was made. The president assumes the responsibility for making this summary, since there was insufficient time for it to be reviewed by the board prior to this hearing. While the summary is representative in the sense that it records the majority view in a given issue, it is important to note that a spectrum of opinion exists on some matters. In order to remain as objective as possible and to present the committee with a source of authoritative opinion, there is appended a selection of quotations, categorized by subject matter, from the statements of the board. Those desiring a more detailed sampling of opinion than the summary can give may refer to this appendix.

In general, the board of directors seems to feel that three aspects of America's space program need discussion and examination—its planning, its funding, and its technical goals. The following is a résumé of their views on these matters:

1. Planning

The members of the board of directors feel that the present planning for the American space program could be improved. Its weakness lies in the absence of a clearly defined national policy on space. One day space is regarded as the key to the Nation's survival, the next as an expensive gamble which is largely irrelevant to our national destinies. Achievements in space are considered to be a revealing index of a country's technology and hence its position in the world; but they are also deprecated as mere propaganda, valuable only for swaying the have-not nations. The planning and funding of space projects are affected critically by these oscillations of opinion, often in a damaging fashion.

We as a Nation should decide, first of all, how important we feel space to be, and then be prepared act upon the consequences of our decision.

The American Rocket Society would like to make its position clear in this matter. It believes that the exploration of space is and will be of central national importance, and that the welfare of this country depends in large part upon the extent to which it is willing to accept the challenge of this new frontier. It believes this attitude practical, not romantic, for it sees space technology as a fruitful area for research. Space technology requires the solution of new problems in metallurgy, physics, mathematics, information theory and communications, fabrication techniques, nuclear power, and much more. These are matters which the American Rocket Society directors feel should not be neglected.

Once we have decided that space is important we should set a series of long-range goals for ourselves. This is essential, for the space race is a costly one to enter as a competitor and only countries who plan wisely will win. We need to appreciate the fact that space age leadtimes are longer than those of the pre-Sputnik tank or jetplane. For example, if we envision interplanetary travel as part of our national capability in 25 years, a substantial amount of time should be devoted now to nuclear propulsion and recoverable boosters. If we take a long-range view we shall also see that education is a most important commodity, and thus begin now to set up scholarship programs. We might also set up national laboratories in conjunction with our leading universities so that we can utilize their resources and enhance the education of scientists. If we want to compete 25 years hence, these things should be done now.

Once we have defined our aims for the space program, we shall be able to establish a series of logical steps by which to achieve them. We shall also have a series of meaningful criteria for assigning priorities to programs, rather than day-to-day switches of opinion that are costly in money and development time. We shall have, in short, a unified development plan which will be an expression of national purpose. This step must be taken before an integrated research and development program is possible.

These recommendations do not necessarily imply reorganizing the administration of our space program. While a few members of the board feel that all space and military efforts should be gathered under a single officer of Cabinet rank, most seem to think our present administrative setup will be adequate if it is properly used. Reorganization can markedly reduce the effectiveness of

groups, and it is often as much as a year before a reorganized group regains its efficiency. We are too far behind as it is, they feel, to permit such delays. What we need is clearly defined goals, not reshuffling.

2. Funding

The area in which the lack of organized purpose is perhaps most clearly in evidence is funding. Like our planning, funding should be geared to a series of long-range purposes based on a realistic appraisal of our national resources. Yet too often it is a series of catch-as-catch-can policies. The board of directors feels that funding should be allocated for at least 5 years in advance, preferably longer. The funding for initial phases of a project should be firm, for latter periods flexible enough to account for possible developments.

Funding of this sort would give a continuity to the efforts of both planners and doers. As things presently stand, budgetary oscillations sometimes wreck technological effort. At great expense a group of experts is gathered, organized, made efficient by experience, and then, just as it is beginning to function productively, suddenly disbanded because of a budgetary cutback. We must prevent such situations. They waste time and money, and they can force some of our better men out of defense projects, where we urgently need them, into more stable occupations. We must fund, in short, in such a way as to permit the continued effort of experienced groups.

The board feels that funding has been conspicuously deficient in the field of basic research. More funds are badly needed in this area. Furthermore, a short-term funding structure is incongruous with the nature of fundamental research. The length of the funding should be determined by the nature of the project, not by arbitrary fiscal dates.

The board urges that unless we take a long-range view of these matters, the bill for the conquest of space will be unnecessarily high.

3. Technical goals

While the general feeling of the board is that we should explore as many aspects of space as possible, several projects were called out for special attention. First, emphasis should be given to those high-performance vehicles and powerplants which require 5- to 10-year leadtime and without which major exploratory work cannot be done. These include million-pound class recoverable boosters, medium scale rockets using new energetic propellants, nuclear rockets of 100,000 pounds thrust and up, and electrical propulsion rockets of the order of one-tenth pound thrust. The board suggests increased studies in bioastronautics, astronomy, astrophysics, metallurgy, and solid state physics. As a means of gathering data for these studies, they suggest an integrated orbital system consisting in part of satellites used as engineering laboratories. Such a system could include provision for global communications and weather prediction in addition to basic research. Several feel that a program to take instrumented vehicles near and to the Moon should be pursued. The vehicles would be used to study the moon, and determine the feasibility of its use as a base or station for interplanetary explorations.

Some members point out that military and political pressures are exerted by a country's technical and scientific achievements. They hold that we must not force an artificial separation between the scientific and military potential of space, and that we must be fully aware of possible military aspects of space if we are to assure ourselves of an opportunity to explore space peacefully.

APPENDIX

QUOTATIONS FROM THE LETTERS AND TELEPHONE CONVERSATIONS

The following quotations, listed under a series of representative topics, are taken from the letters and phone calls of the members of the board of directors.

The topics covered are:

Planning
Funding
Objectives of space program
Important research areas
Basic research
Military aspects of space
Education
Administration of space program

PLANNING

"Our present program of basic research in space science is operated on a 'catch-as-catch-can' basis. Scientists have been funded to produce all the various payload packages without preassignment of vehicles or dates. Because of the limited number of vehicles available, payloads have been integrated with groups of incompatible experiments in order to give everybody a chance. The end result, however, is never entirely satisfactory to any of the parties involved."

"We must recognize the need for a sound space science program apart from the need for propaganda 'spectaculars.' If the political need demands the spectacular achievement, we should evaluate the present Russian lead and not dissipate our efforts in the preparation of missions in which there is little chance of our being first."

"In contrast to the urgency being expressed in the booster program * * * there seems to be little emphasis on planning the missions. For example, plans have been discussed with respect to a soft lunar landing of an automated tractor-type laboratory, capable of performing a variety of experiments such as X-ray fluorescence analysis of the lunar surface, measurement of its radioactivity, and the taking and analysis of core samples. To my knowledge, no firm decisions have been taken to develop the payload in spite of the fact that several years of intensive effort are hardly adequate to perfect such instrumentation. It seems likely that we shall have the boosters but would have to wait for the payloads."

"I believe that one of the most desirable combinations of the 'spectacular' with highly scientific objectives is a space observatory to extend astronomy into the ultraviolet and X-ray wavelengths and long wavelength radio spectrum beyond the ionospheric cutoff. On the assumption that we can look forward to boosters capable of placing several-ton payloads in very high orbits by the middle 1960's, we barely have the time to perfect the necessary instrumentation for a space observatory even on a crash basis. Plans for ultimately instrumenting such an observatory have been tentatively formulated but it will require an intensive program, starting with rocket astronomy in its present primitive state and advancing through a series of developmental payloads and broad sky surveys in order to achieve the 'know-how' for the final package. For lack of adequate support and emphasis, these steps are progressing so slowly at this time that I see little hope of effecting the ultimate payload in time to match the vehicular development."

"It is suggested that 10-year programs should be established by both the military and the civilian space organizations. The first year's programs should be in considerable detail, with each succeeding year requiring less specific program targets. Also, duplicate approaches and backup programs should be permissible in the early, less expensive years."

"General approval should be expressed for the NASA 10-year program of space exploration, as recently announced in the press. However, NASA should be urged by Congress to make use of American private industry wherever possible to develop its overall vehicles and launching systems and stop trying to do it all in its own house."

"If we are going to think of interstellar travel, even in the far distant future, it is well to undertake some research programs now that will eventually lead to the possibility."

"It is highly desirable that any research program be planned in logical steps, so that the next generation may continue it without serious loss of time that could be attributed to initial misdirection or initial lack of foresight."

FUNDING

"The subject of funding should certainly be considered. A congressional plan of budgeting the space program on a 5-year basis with a firm 1-year program and planning for the additional 4 years would be highly desirable. This would allow a continuity and planning that would benefit both the doing and the funding organizations."

"With reference to the funding, in my opinion the problem is more in the incorrect handling than the money available. The structure of short-term contracts for fundamental research is essentially paradoxical. The funding of a research program on the basis of an artificial period of a fiscal year is basically untenable."

OBJECTIVES OF SPACE PROGRAM

"The objectives of the U.S. space program should be the exploration of space, its use, and exploitation of its resources for both civilian and military purposes."

"From the scientific viewpoint, the intermediate objectives would involve a thorough geodesian mapping of the Earth, the complete description of geomagnetic field, aurora, particle trapping, airglow, particle interaction, and ionospheric phenomena, and a more complete grasp of meteorology than available at present. The emphasis in the exploration of the planetary system would be in natural and life sciences, chemistry of interplanetary space, meteorites, cosmic rays, magnetohydrodynamic phenomena, as well as providing opportunities for tests of general field theory, relativity, etc."

"There are three major areas which the U.S. space program should include: These are:

"1. Integrated orbital system: The system should be controlled or coordinated by a single agency. It should include subsystems such as communications satellites, meteorological satellites, instrumented and manned research vehicles, and manned space research laboratories.

"Objectives:

"(*a*) Provide research capabilities for medicine and other basic sciences.

"(*b*) Provide common services such as communications and weather prediction.

"(*c*) Explore potential uses and benefits of orbital environments and applications of orbital operations.

"(*d*) Ascertain possible military exploitation of space.

"2. Lunar exploration. The program should include instrumented vehicles to and near the Moon, manned lunar circumnavigation, and manned landings.

"Objectives:

"(*a*) Provide basic research information about the Moon and its environment.

"(*b*) Determine desirability and feasibility of establishing manned lunar base and its functions.

"3. Planetary and interplanetary exploration. The program should include instrumented probes to and near planets, later instrumented landings, and manned planetary exploration if determined to be desirable.

"Objectives:

"(*a*) To provide basic information about other planets of the solar system and the environment of interplanetary space.

"(*b*) To determine desirability and feasibility of manned planetary exploration."

IMPORTANT RESEARCH AREAS

"The large chemical boosters of 1 million to 1,500,000 pound thrust should be continued with improvements incorporated as technology permits. Clustering of the engines should be considered to increase the overall thrust level available for ambitious missions."

"The high energy (LOX-hydrogen) engine field should be expanded to incorporate the presently planned 200,000 pound thrust engine size. A 3 year review of the high energy program should be made to determine if the requirement exists for the next larger engines, possible 500,000-pound thrust (LOX-hydrogen)."

"An immediate start should be made in the nuclear engine field. A thrust of 75,000- to 90,000-pound size (to fit present reactor design) would seem to be a first logical step. Such an engine should be ready for flight about 1965. A review of the nuclear program in about 3 years should be made to determine the feasibility and requirements for a larger thrust nuclear rocket engine."

"The electrical propulsion field could be enhanced by the initiation of a 0.1-pound thrust engine at this time. Such an engine could be ready for flight in 1964 to 1965. A review of the electrical propulsion progress should be made in 1962 to determine the requirements for a larger engine—probably of the 1- to 10-pound thrust size."

"Engineering design data are needed in order to exploit most economically and efficiently our new space frontier. Several engineering laboratories (initially unmanned, of course) should be put into space to gather the needed information."

"The experimental and development work leading to a nuclear rocket engine should be expedited, so that the only presently known type of high-thrust, high-specific impulse rocket powerplant can be available sooner, to economize on the total bill for space exploration. Concurrently with the increase of emphasis should come design and experimental studies leading to an engine of a thrust size ($\geq$300K) useful for space exploration, together with initiation of design studies of the optimum (costwise) airframe into which this powerplant can be integrated."

"Serious studies should be stepped up in bioastronautics, a man's survival in space and on other planets. This might include research into closed ecological systems, food cycles, biological cycles, resynthesis, respiratory quotient, and use of algae."

"More research in the area of astronomy and astrophysics should be initiated."

BASIC RESEARCH

"We cannot recommend too strongly the need for more adequate funding in basic research, particularly in the materials areas of metallurgy and solid state. A higher level of basic research support is also definitely called for in those types of space science based on ground level observations. In this latter category our national radio astronomy effort is sadly neglected."

"Basic research should be taken out of the hands of the Department of Defense and the AEC (the two Government agencies that spend most of the Federal funds in this area) and put into the hands of a civilian agency staffed by professional scientists, and the amount of Federal support in this field should be sharply increased."

"Basic research in the space field should be provided with long-range funding rather than the present annual budget. The length of the funding should be dependent upon the nature of the project."

"More Government support should be given to long-range fundamental research so that the researchers can serenely concentrate on their work rather than coming out with inconsequential results to satisfy quarterly or yearly nontechnical contractual requirements. Fundamental research studies should not be governed by development and production divisions."

"We should have a number of national laboratories for basic studies. Whenever possible these laboratories should be located in close proximity to universities to utilize buried talent to a maximum and to maximize the education of many more scientists."

MILITARY ASPECTS OF SPACE

"Ballistic missiles now are needed to complement long-range manned bombers in an overall deterrent force. Similarly, military space vehicles will be needed to complement the ballistic missile force. These military space vehciles will be for reconnaissance, early warning, communications, weather, and navigation purposes."

"The military must support and is supporting President Eisenhower's policy that space is for peace. But, in order to ensure that it is only used for peace by all who might enter it, we have to explore space thoroughly and determine the military potential. Once we learn what is possible militarily, we will have to exploit this potential and provide in space the deterrent force that is necessary there. In order to determine the military potential, many scientific experiments will have to be conducted, but if we make only scientific explorations of space, then we take a big chance in falling behind militarily as I am sure the Russians will utilize anything that they can in a military way in order to achieve a military superiority."

"We may not know the nature of an effective military space force now, but when we do identify it and implement it, we will find that a strong deterrent space force is the best way to ensure 'Space is for Peace.' "

"It is not nearly so important at the present stage of international affairs to win the scientific race into space as to win the ICBM missile race and to win the overall race for retaliatory power. If the financial choice must be made between speeding up Saturn and, say, an airborne alert, actual civil defense, a reactivation of the B–70 program, or a missile speedup, then the latter projects should be voted. A year's delay in Saturn will not endanger the nation; an inadequate retaliatory power will."

"Military space systems offer hope for removing the H-bomb threat from civilian populations."

"The United States should not sign any pact agreeing only to the peaceful exploitation of space (compare use of the ocean, in peace and in war)."

EDUCATION

"One area that needs heroic measures is education. Another is the support of basic research. Proper education is costly and large amounts of Federal tax money will be required to do the job. This is especially true in the field of higher education."