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1970 NASA AUTHORIZATION

GOVERNMENT

Storage

HEARINGS

BEFORE THE

COMMITTEE ON

SCIENCE AND ASTRONAUTICS

U.S. HOUSE OF REPRESENTATIVES

NINETY-FIRST CONGRESS

FIRST SESSION

ON

H.R. 4046, H.R. 10251

(Superseded by H.R. 11271)

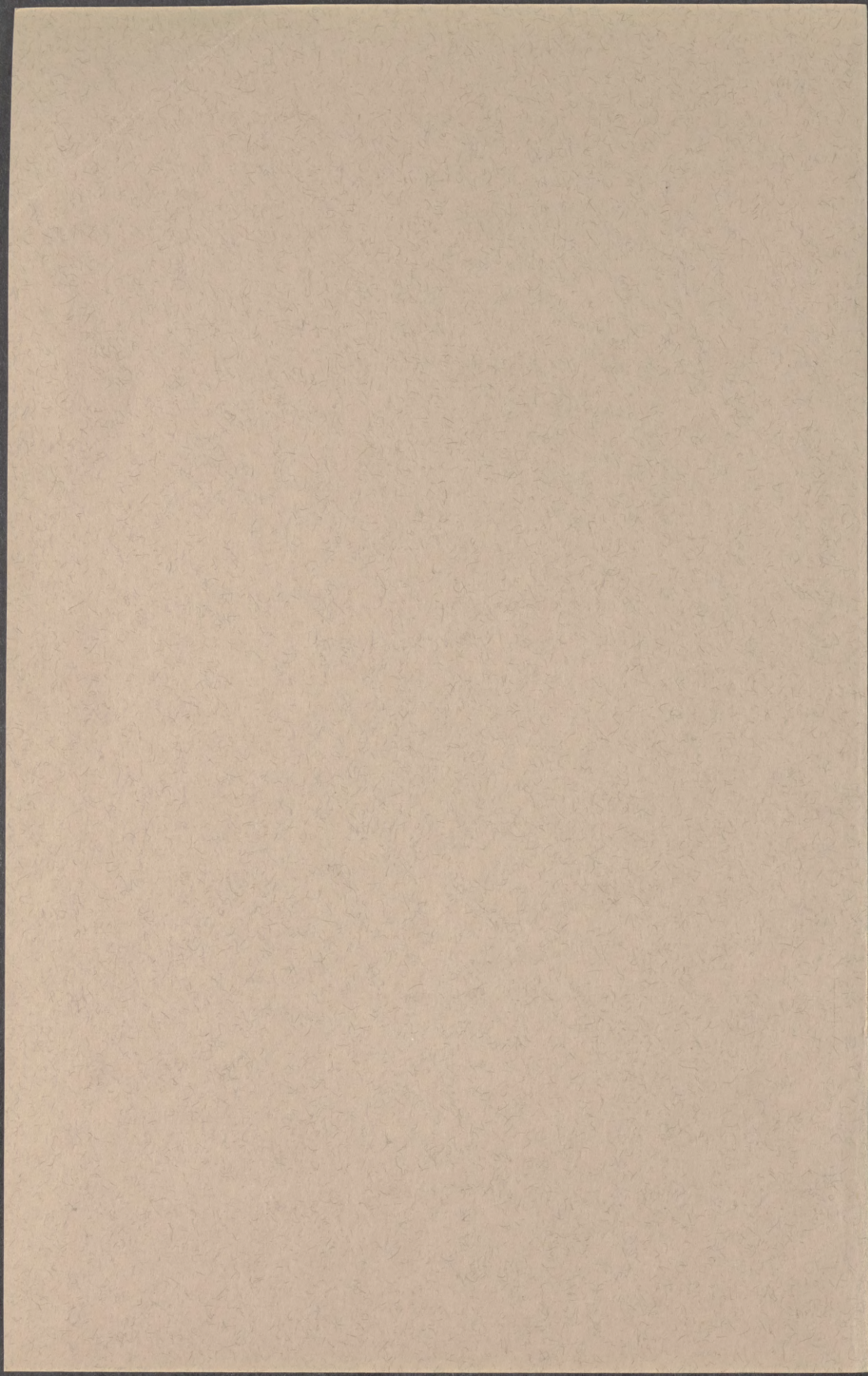
MARCH 4, 5, 1969

[No. 3]

Part 1

Printed for the use of the Committee on Science and Astronautics





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CONTENTS

STATEMENTS

March 4, 1969:

Dr. Thomas O. Paine, Administrator, National Aeronautics and Space Administration-----	Page 6
Dr. George E. Mueller, Associate Administrator, Office of Manned Space Flight, National Aeronautics and Space Administration-----	14
Bruce T. Lundin, Deputy Associate Administrator, Office of Advanced Research and Technology, National Aeronautics and Space Administration-----	25

March 5, 1969:

Harold B. Finger, Associate Administrator for Organization and Management, National Aeronautics and Space Administration-----	49
John E. Naugle, Associate Administrator for Space Science and Applications, National Aeronautics and Space Administration-----	62
Gerald M. Truszynski, Associate Administrator for Tracking and Data Acquisition, National Aeronautics and Space Administration--	78

(III)

THE HISTORY

The history of the United States is a story of the struggle for freedom and independence. It is a story of the people who have fought for the rights of the individual and the rights of the nation. It is a story of the people who have built a great and powerful country out of a small and weak one. It is a story of the people who have made the United States a land of opportunity and hope for all.

1970 NASA AUTHORIZATION

TUESDAY, MARCH 4, 1969

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

The committee met at 10:10 a.m., in room 2318, Rayburn House Office Building, Hon. George P. Miller (chairman of the committee) presiding.

The CHAIRMAN. The committee will be in order.

Without objection we will proceed. Other members are on their way.

Today we start committee hearings on H.R. 4046, the NASA authorization bill for fiscal year 1970.

(H.R. 4046 is as follows:)

[H.R. 4046, 91st Cong., first sess.]

A BILL To authorize appropriations to the National Aeronautics and Space Administration for research and development, construction of facilities, and research and program management, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there is hereby authorized to be appropriated to the National Aeronautics and Space Administration:

(a) For "Research and development," for the following programs:

- (1) Apollo, \$1,651,100,000;
- (2) Space flight operations, \$236,627,000;
- (3) Advanced missions, \$2,500,000;
- (4) Physics and astronomy, \$119,600,000;
- (5) Lunar and planetary exploration, \$146,800,000;
- (6) Bioscience, \$32,400,000;
- (7) Space applications, \$135,800,000;
- (8) Launch vehicle procurement, \$124,200,000;
- (9) Sustaining university program, \$9,000,000;
- (10) Space vehicle systems, \$30,000,000;
- (11) Electronics systems, \$35,000,000;
- (12) Human factor systems, \$23,600,000;
- (13) Basic research, \$21,400,000;
- (14) Space power and electric propulsion systems, \$39,900,000;
- (15) Nuclear rockets, \$36,500,000;
- (16) Chemical propulsion, \$25,100,000;
- (17) Aeronautical vehicles, \$78,900,000;
- (18) Tracking and data acquisition, \$298,000,000;
- (19) Technology utilization, \$5,000,000.

(b) For "Construction of facilities," including land acquisitions, as follows:

- (1) Electronics Research Center, Cambridge, Massachusetts, \$8,088,000;
- (2) Goddard Space Flight Center, Greenbelt, Maryland, \$670,000;
- (3) John F. Kennedy Space Center, NASA, Kennedy Space Center, Florida, \$12,500,000;
- (4) Langley Research Center, Hampton, Virginia, \$4,767,000;
- (5) Manned Spacecraft Center, Houston, Texas, \$1,750,000;
- (6) Wallops Station, Wallops Island, Virginia, \$500,000;
- (7) Various locations, \$26,425,000;
- (8) Facility planning and design not otherwise provided for, \$3,500,000.

(c) For "Research and program management," \$650,900,000.

(d) Appropriations for "Research and development" may be used (1) for any items of a capital nature (other than acquisition of land) which may be required for the performance of research and development contracts, and (2) for grants to nonprofit institutions of higher education, or to nonprofit organizations whose primary purpose is the conduct of scientific research, for purchase or construction of additional research facilities; and title to such facilities shall be vested in the United States unless the Administrator determines that the national program of aeronautical and space activities will best be served by vesting title in any such grantee institution or organization. Each such grant shall be made under such conditions as the Administrator shall determine to be required to insure that the United States will receive therefrom benefit adequate to justify the making of that grant. None of the funds appropriated for "Research and development" pursuant to this Act may be used for construction of any major facility, the estimated cost of which, including collateral equipment, exceeds \$250,000, unless the Administrator or his designee has notified the Speaker of the House of Representatives and the President of the Senate and the Committee on Science and Astronautics of the House of Representatives and the Committee on Aeronautical and Space Sciences of the Senate of the nature, location, and estimated cost of such facility.

(e) When so specified in an appropriation act, (1) any amount appropriated for "Research and development" or for "Construction of facilities" may remain available without fiscal year limitation, and (2) maintenance and operation of facilities, and support services contracts may be entered into under the "Research and program management" appropriation for periods not in excess of twelve months beginning at any time during the fiscal year.

(f) Appropriations made pursuant to subsection 1(c) may be used, but not to exceed \$35,000, for scientific consultations or extraordinary expenses upon the approval or authority of the Administrator and his determination shall be final and conclusive upon the accounting officers of the Government.

(g) No part of the funds appropriated pursuant to subsection 1(c) for maintenance, repairs, alterations, and minor construction shall be used for the construction of any new facility the estimated cost of which, including collateral equipment, exceeds \$100,000.

SEC. 2. Authorization is hereby granted whereby any of the amounts prescribed in paragraphs (1), (2), (3), (4), (5), (6), and (7) of subsection 1(b) may, in the discretion of the Administrator of the National Aeronautics and Space Administration, be varied upward 5 per centum to meet unusual cost variations, but the total cost of all work authorized under such paragraphs shall not exceed the total of the amounts specified in such paragraphs.

SEC. 3. Not to exceed one-half of 1 per centum of the funds appropriated pursuant to subsection 1(a) hereof may be transferred to the "Construction of facilities" appropriation, and, when so transferred, together with \$10,000,000 of the funds appropriated pursuant to subsection 1(b) hereof (other than funds appropriated pursuant to paragraph (8) of such subsection) shall be available for expenditure to construct, expand, or modify laboratories and other installations at any location (including locations specified in subsection 1(b)), if (1) the Administrator determines such action to be necessary because of changes in the national program of aeronautical and space activities or new scientific or engineering developments and (2) he determines that deferral of such action until the enactment of the next authorization Act would be inconsistent with the interest of the Nation in aeronautical and space activities. The funds so made available may be expended to acquire, construct, convert, rehabilitate, or install permanent or temporary public works, including land acquisition, site preparation, appurtenances, utilities, and equipment. No portion of such sums may be obligated for expenditure or expended to construct, expand, or modify laboratories and other installations unless (A) a period of thirty days has passed after the Administrator or his designee has transmitted to the Speaker of the House of Representatives and to the President of the Senate and to the Committee on Science and Astronautics of the House of Representatives and to the Committee on Aeronautical and Space Sciences of the Senate a written report containing a full and complete statement concerning (1) the nature of such construction, expansion, or modification, (2) the cost thereof, including the cost of any real estate action pertaining thereto, and (3) the reason why such construction, expansion, or modification is necessary in the national interest, or (B) each such

committee before the expiration of such period has transmitted to the Administrator written notice to the effect that such committee has no objection to the proposed action.

SEC. 4. Notwithstanding any other provision of this Act—

(1) no amount appropriated pursuant to this Act may be used for any program deleted by the Congress from requests as originally made to either the House Committee on Science and Astronautics or the Senate Committee on Aeronautical and Space Sciences,

(2) no amount appropriated pursuant to this Act may be used for any program in excess of the amount actually authorized for that particular program by sections 1(a) and 1(c), and

(3) no amount appropriated pursuant to this Act may be used for any program which has not been presented to or requested of either such committee,

unless (A) a period of thirty days has passed after the receipt by the Speaker of the House of Representatives and the President of the Senate and each such committee of notice given by the Administrator or his designee containing a full and complete statement of the action proposed to be taken and the facts and circumstances relied upon in support of such proposed action, or (B) each such committee before the expiration of such period has transmitted to the Administrator written notice to the effect that such committee has no objection to the proposed action.

SEC. 5. It is the sense of the Congress that it is in the national interest that consideration be given to geographical distribution of Federal research funds whenever feasible, and that the National Aeronautics and Space Administration should explore ways and means of distributing its research and development funds whenever feasible.

SEC. 6. This Act may be cited as the "National Aeronautics and Space Administration Authorization Act, 1970".

The CHAIRMAN. It is my intention to hold 2 days of full committee hearings which will be conducted as a general briefing on the fiscal year 1970 program. Thereafter the subcommittees are free to start hearings on their respective portions of the budget, at which time a detailed and searching study of the programs can be made.

The list of witnesses for today and tomorrow's committee sessions are before each member. You will note that we have invited the Acting Administrator and the program directors to appear on these 2 days. I have asked that they file their detailed statements for the record and proceed at this time to summarize those statements.

So that we can be sure to receive the testimony of each witness in the allotted time, I will ask that all the witnesses this morning, and again tomorrow morning, be permitted to complete their summaries, after which I will entertain questions for as long as time will permit. It should be remembered that all of the program directors will be appearing before the subcommittees and at that time you will be given ample opportunity to ask questions and examine the various programs in detail.

To repeat a statement I made at the organizational meeting of the full committee on January 30, it is my hope that the subcommittee will be prepared to report to the full committee on Wednesday, March 26. This will give the full committee about a week to consider those items not previously considered by any subcommittee, receive subcommittee reports, and mark up the bill before the Easter recess, which begins April 3. The committee staff can then proceed to prepare the report during the recess.

I might also say that one reason we are pressing to finish the bill before the Easter recess is that we have received word from the Ap-

appropriation's Independent Offices Subcommittee to the effect that they intend to mark up on April 16, only 2 days after the recess. It is helpful to them to know our committee's actions prior to their mark up.

Now we will proceed to hear witnesses, and I would like to first welcome the Acting Administrator, Dr. Thomas O. Paine.

Perhaps, Doctor, you would like to make a short statement with respect to Apollo 9, and give us some up-to-the-minute briefing on what has transpired.

Dr. PAINE. Thank you, Mr. Chairman. We do have a current statement from the Mission Director, and I will ask Dr. George Mueller to give you the report.

Dr. MUELLER. Mr. Chairman, as you know, and many of you were actually at the launch yesterday, this was the third ontime launch of the Saturn V vehicle, and it was completely successful.

Now, there was in the course of part of the flight one anomaly that appeared, that was that the guidance system on board indicated a different orbit than that which the vehicle actually achieved. The problem has been traced to a drift in the bias of the accelerometer, and this can be corrected and has been corrected by shifting bias from the ground in the computation. We don't anticipate any further difficulty with that.

The command and service module did separate successfully from the launch vehicle, did complete its docking with the lunar module, and did successfully separate from the SIVB stage. That part of the operation went without any hitch.

There was one problem that occurred in that period of time and that was the translation control of the spacecraft, the ability to move in the Y axis, which was caused by the closing of a set of switches on the quad C, that is one of the four quads for reaction control system engines around the vehicle. That was corrected by placing the switches in the proper position, and the flight then continued.

We have not yet decided, or been able to trace, what caused the switches beyond position. The SIVB did restart for the third time, and is now in an orbit about the sun. The only anomaly there was a thrust reduction during the end of the burn, which did not affect the guidance or the operation of the vehicle. We are still analyzing that for its implications on the next flight, which will be a unit mission.

We did carry out the first dock propulsion system burn yesterday and it was successful. We carried out the second this morning at 9:12 a.m., and it was successful. What we were trying to learn there was whether there was some instability in the control system, particularly when you have the command and service module dock, and the lunar module has to be stable. It was completely stable, and the crew is now going to carry out two more burns of the service propulsion system today; tomorrow they will enter into the lunar module for the first time and check it out, and carry out their first descent with the propulsion system burn, then on Thursday and Friday of this week we will have the big events, the first extravehicular activity on Thursday, and on Friday the rendezvous docking, if all goes well.

The CHAIRMAN. Thank you very much.

Dr. Paine, we will be very happy to hear from you, and I invite you to proceed.

(The biographical sketch of Dr. Thomas O. Paine is as follows:)

DR. THOMAS O. PAINE

Dr. Thomas O. Paine was born in Berkeley, Calif., November 9, 1921, son of Commodore and Mrs. George T. Paine, USN (retired). He attended public schools in various cities and was graduated from Brown University in 1942 with an A.B. degree in engineering.

In World War II he served as a submarine officer in the Pacific, and in the Japanese occupation. He qualified in submarines, and as a Navy deep-sea diver, and was awarded the Commendation Medal and submarine combat insignia with stars.

In 1946-49, Dr. Paine attended Stanford University, receiving an M.S. degree in 1947 and Ph. D. in 1949 in physical metallurgy. In 1946 he married Barbara Helen Taunton Pearse, of Perth, Western Australia. They have four children: Marguerite Ada, George Thomas, Judith Janet, and Frank Taunton.

Dr. Paine worked as a research associate at Stanford University from 1947 to 1949, where he made basic studies of high-temperature alloys and liquid metals in support of naval nuclear reactor programs. He joined the General Electric Research Laboratory in Schenectady, N.Y., in 1949 as research associate, where he initiated research programs on magnetic and composite materials. This work led to the first demonstration of the shape anisotropy effect in single-domain magnetic particles, and to the basic patents on "Lodex" permanent magnets. In 1951 he transferred to the meter and instrument department, Lynn, Mass., as manager of materials development, and later as laboratory manager. Major projects ranged from development of photocells and non-arc-tracking organic insulation to solid-state nuclear reactor control systems and aircraft instrumentation. For the successful fine particle magnet development program Dr. Paine's laboratory received the 1956 Award for Outstanding Contribution to Industrial Science from the American Association for the Advancement of Science.

From 1958 to 1962 Dr. Paine was research associate and manager of engineering applications at GE's research and development center in Schenectady. This involved organizing and managing a new laboratory component engaged in technical-economic studies and development programs in lasers, medical electronics, electric vehicles, and many other fields.

In 1963-68 he was manager of TEMPO, GE's center for advanced studies in Santa Barbara, Calif. This 400-man, long-range planning and interdisciplinary study group conducted interdisciplinary research for Federal, State, and local governments, foreign nations, banks, and industry. These programs ranged from criteria for selection of model cities to the logistics support system for Polaris submarines, and from computerized management information systems to economic development in Africa. About 15 percent of these studies were for top management of the parent company.

On January 31, 1968, President Johnson appointed Dr. Paine Deputy Administrator of NASA. Upon the retirement of Mr. James E. Webb on October 8, 1968, President Johnson named Dr. Paine Acting Administrator of NASA.

Dr. Paine's professional activities have included chairmanship of the 1962 Engineering Research Foundation-Engineers Joint Council Conference on Science and Technology for Less Developed Nations; secretary and editor of the E.J.C. Engineering Research Committee on the Nation's Engineering Research Needs 1965-85; member, advisory committee and local chairman, Joint American Physical Society-Institute of Electrical and Electronic Engineers International Conference on Magnetism and Magnetic Materials; chairman, special task force for U.S. Department of Housing and Urban Development; lecturer, U.S. Army War College and American Management Association; Advisory Board, AIME Journal of Metals; member, Basic Science Committee of IEEE and the Research Committee, Instrument Society of America.

Dr. Paine is a member of Sigma Xi; New York Academy of Sciences; American Physical Society; Institute of Electrical and Electronic Engineers; American Institute of Mining, Metallurgical, and Petroleum Engineers; American Society for Metals; Institute of Metals (London); Submarine Veterans of World War II; American Society of Naval Engineers; Society for the History of Technology; Marine Historical Association; American Museum of Electricity; Newcomen Society (London); Naval Historical Foundation; American Association for the

Advancement of Science; National Association for the Advancement of Colored People; U.S. Naval Institute; Navy League; Association of the U.S. Army; American Ordnance Association; Instrument Society of America; and associate fellow, American Institute of Aeronautics and Astronautics.

**STATEMENT OF DR. THOMAS O. PAINE, ACTING ADMINISTRATOR,
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION**

Dr. PAINE. Mr. Chairman and members of the committee, we are appreciative of the opportunity to participate in the start of your hearings on the NASA authorization for fiscal year 1970, and to testify in support of H.R. 4046 which embodies the recommendations in the fiscal year 1970 budget.

While this is my first appearance before the full committee, I am well aware and very appreciative of the importance and value of your reviews of the NASA program each year. The need is especially great this year for thoughtful discussion and clear debate to establish the direction and pace of the Nation's space programs. At a time when the United States faces many problems in many fields, it is important that the national priority issues involved in moving steadily ahead in space—and equally important, in failing to move ahead—be clearly understood. In my view, the Congress shares with the new administration a great responsibility for national leadership in aerospace at this time. The U.S. space and aeronautics programs, and NASA as the agency with primary responsibility for them, particularly need your counsel and support in the second decade of the space age just as they did in the first. We hope that after your review of our accomplishments and plans, you will conclude that NASA's programs continue to deserve the confidence and support of the Nation.

As in previous years, the associate administrators in charge of each of our major offices will testify on the details of our accomplishments during the past year, the current status of our programs, the problems we have encountered, and the program plans and resource requirements recommended in the fiscal year 1970 budget. Dr. Mueller, Mr. Lundin, Mr. Finger, Dr. Naugle, and Mr. Truszynski will present summary statements today and tomorrow to the full committee, and, together with their associates, give detailed statements and supporting testimony before each of your subcommittees. These gentlemen are well known to the committee except perhaps for Mr. Bruce Lundin, the Deputy Associate Administrator for Advanced Research and Technology. He is appearing in place of Mr. James Beggs, who we are proud to say has been appointed by President Nixon to be Under Secretary of Transportation. I may add that all of us in NASA are also proud that Dr. Robert C. Seamans, Jr., who served NASA so long and so well as Associate and Deputy Administrator, has become Secretary of the Air Force.

My statement will be confined to an overview of our current situation and plans, and the resources requested in the fiscal year 1970 budget. First let me highlight some of our accomplishments during the past year:

In manned space flight we have demonstrated the flight worthiness of the Saturn-Apollo system. The problems revealed in the unmanned flight test of Apollo 6 last spring—the "POGO" vibration and J-2 engine restart failure—were successfully analyzed and corrected.

Apollo 7 demonstrated with a perfect mission the capabilities and performance of the Block II Apollo spacecraft, incorporating the safety features determined to be necessary after the Apollo 204 fire.

Apollo 8, I hardly need to say, demonstrated in spectacular fashion that the entire Saturn V-Apollo system—minus the lunar module—and our ground tracking, communication, and control systems, can indeed do what they were designed to do: take men out to the Moon safely, and in a precisely controlled trajectory achieve a preplanned 70-mile altitude lunar orbit, then return to Earth to land less than 2,000 yards from the selected target. Apollo 8 also served to remind the entire world of what many had forgotten and some had perhaps begun to doubt: that manned exploration of space is a profoundly moving experience which people everywhere can share, through the miracle of space communications, and feel a sense of participation and triumph in this major achievement of the human race.

In space science, two of the most significant accomplishments, among many, have been the successful launching and operation of satellites equipped to observe the far reaches of the universe in ways that are impossible from Earth. One was the Radio Astronomy Explorer—RAE-A or Explorer 38—a small satellite equipped to observe radio astronomy sources in wave lengths that cannot get through to the Earth. The RAE, with its 1,500-foot-long antenna, showed the material in the interstellar medium is more dense than we thought, and that the sun flares surprisingly in these long wave lengths.

The other was OAO-II, the largest and most complex unmanned satellite we have yet launched, which is observing stars and galaxies in ultraviolet light which is likewise not visible from Earth.

Preliminary analysis of the ultraviolet light from galaxies indicates that faint hot stars are more numerous than previously assumed. If this is so, it will increase our estimates of distances to the furthest of these objects and hence, of the size of the observable region of the universe. In addition, the observed ultraviolet spectra of some stars may provide an important new tool for measuring the abundance of elements in their atmospheres.

In the planetary area, the development of the Mariner spacecraft was successfully completed on the tight schedule required to meet the 1969 Mars launch window. Mariner F, renamed Mariner VI, is now 1,425,000 miles from Earth, a week and a day on its 226-million-mile voyage to Mars; Mariner G is on schedule being readied for launch later this month. The near-encounter photographs from Mariner 6 and 7 will have 10 times the resolution of those obtained several years ago by Mariner IV.

In space applications we have used our Applications Technology Satellites effectively in the monitoring and study of tornadoes and hurricanes. Earth resources work from aircraft has paved the way for experiments from space.

In space technology, steady progress has continued. Our nuclear technology program has continued to go extremely well, leading to tests of an experimental engine system during the next several months. The SNAP-8 nuclear power generating system has accumulated several thousand hours of bread-board operation. In our research on lifting reentry bodies for future space shuttle operations, the HL-10 manned test vehicle moved into the powered flight test phase.

In aeronautics our noise reduction program has moved ahead with experimental demonstrations of the noise reduction possible through aeronautics design, an extremely promising potential breakthrough is the new supercritical wing, which we expect can increase the speed and maneuverability of subsonic aircraft just as the famous "coke bottle" fuselage design of several years ago for supersonic aircraft.

The tracking and communications network—ground stations, ships, aircraft, satellites, and switching centers—required for the Apollo program is now in place and was successfully demonstrated in the Apollo 8 flight. The television you all saw from a quarter of a million miles in space was only one of the networks' outstanding accomplishments.

In the field of international cooperation, the United States has continued to press ahead as rapidly as foreign interest, funding, and attitudes permit. Thus, NASA launched a record four foreign satellites in the past year, two of them contributed by the European Space Research Organization and one by Canada. A fourth was launched on a reimbursable basis for ESRO. Other joint programs have progressed as well.

In the past year we have also, of course, encountered problems. I have mentioned the POGO and J-2 engine problem with the Saturn V. As the committee knows, we had launch vehicle failures—now something of a rarity in the space program—with the Thor Agena, the Delta booster, and Centaur stage during the year. There were also two accidents with lunar landing training vehicles, also reported to the committee. I mention these as a reminder that we in NASA are in a highly experimental area and that the possibility of failure always exists. We must not let text-book successes like Apollo 7 and Apollo 8 lull us into overconfidence. It is important that the Congress and the public do not forget that some failures are bound to occur in programs which probe the unknown, and that they are a necessary part of the price of progress.

We have had another kind of problem during the past year—one that is still with us. I refer to the problem of insuring that a high level of accomplishments is continued in our flight programs and that the high quality of our scientific and technical work is maintained during a period of retrenchment and declining resources.

NASA's fiscal year 1969 operating budget is \$762 million below fiscal year 1968 and over \$1 billion below fiscal year 1967. During this same period total nationwide employment on NASA work decreased from an earlier peak of approximately 420,000 people to 270,000 at the end of fiscal year 1968, to about 215,000 at the end of fiscal year 1969, and, under the fiscal year 1970 budget will go to about 190,000 people. The reduction of our NASA civil service during the same period has placed a difficult burden on our program management, coming as it has during the period of our most intense preparations to support the heavy schedule for manned space flight.

It has not been and is not easy to maintain a strong forward-thrusting space program under these conditions. The problem has been compounded by the uncertainties on the future goals and funding levels of the program. Our Center directors and Headquarters managers deserve great credit for the effective leadership they are providing in these difficult circumstances.

Until last October when the final decisions were made by the President on the distribution of the Government-wide reduction in fiscal year 1969 expenditures required of him by the Revenue and Expenditure Control Act, we could not be sure at what level NASA would be permitted to operate in fiscal year 1969. We were able to mitigate somewhat the impact of the reduction that was ultimately made by taking early action to establish in August, as we reported to the committee at the time, an interim fiscal year 1969 operating plan under a self-imposed limitation which, as things turned out, corresponded to the reduction imposed by the President in October. By this timely action we avoided the much more serious consequences of being forced to absorb the entire reduction in the last two-thirds of the fiscal year.

In recent years, the budgets submitted by the President and the funding levels finally approved have required deferral wherever possible of programs pointed at major new objectives. In order to maintain some momentum and preserve important options, we have had to take uneconomical actions to defer programs, curtail the scope and value of projects, stretch out schedules, and reduce planning and preliminary design and development work for future programs.

The combination of reduced and uncertain budget levels with the inability to make firm plans for the future have, in my opinion, lowered the effectiveness of the NASA organization below what it could and should be. The time has come to look ahead and plan the second decade of our space program with an energy and vision equal to that used in planning the first decade.

Let me now turn to the fiscal year 1970 budget.

As the committee knows, the fiscal year 1970 budget we are presenting today is the budget submitted by President Johnson, as required by law, prior to his leaving office. President Nixon has requested the head of each agency and the Bureau of the Budget to review the budget of the previous administration in the light of the policies of the new administration. These reviews are now vigorously underway, but until this process is completed and the President has made his decisions, we cannot say what revisions, if any, may be made.

The NASA fiscal year 1970 budget before you does arrest the steady downward trend of NASA budgets in the past several years and is designed to provide NASA with the same total program level in fiscal year 1970 as we were allowed in our reduced fiscal year 1969 operating plans, even though the authorization request before you shows an apparent decrease. Let me explain:

For fiscal year 1969, the total appropriated by Congress in Public Law 90-550 was \$3.995 billion. Under the requirements of the Revenue and Expenditure Control Act, the President withheld \$117 million, leaving us with a fiscal year 1969 operating plan of \$3.878 billion, including provision for the civil service pay increases becoming effective during the year.

For fiscal year 1970, President Johnson's decision was to provide NASA with the same program level as in the final fiscal year 1969 operating plan, \$3.878 billion. The \$117 million withheld in fiscal year 1969 are "no-year funds" which can be applied to our fiscal year 1970 requirements without further congressional action. Thus, the fiscal year 1970 authorization and appropriation requests now before Con-

gress total \$3.761 billion, \$117 million less than the \$3.878 billion program level the budget recommends.

I have characterized NASA's fiscal year 1970 budget "as a 'holding' budget that provides for progress, but defers critical new program funding decisions to the new administration." Virtually all of the \$3.878 billion requested for fiscal year 1970 is required for the necessary costs of continuing in fiscal year 1970 projects and programs approved and begun in previous years. These include the Apollo program, the limited Apollo Applications program which we were finally able to undertake within our reduced fiscal year 1969 operating plan, the Titan-Mars 1973 program—now called Viking—which was also approved last year, and other programs with which the committee is familiar.

To carry forward previously approved programs in fiscal year 1970 will require about \$3.8 billion. The remainder of our request, about \$70 million, is for previously anticipated extensions of some of our continuing space science and applications programs, such as Mariner-Mercury 1973 mission and the synchronous meteorological satellite, and for starting three principal new programs or major developments:

1. *The Earth resources technology satellite program.*—We have secured approval in this budget to move ahead with the development of experimental Earth resources technology satellites now designated ERTS A and B. If this budget recommendation is approved by the Congress, we will be able to begin satellite testing of multispectral television systems which will enable experimenters in the various Government agencies and universities cooperating in our program to assess experimentally the value of space-collected data in the study and understanding of a variety of Earth resources. For many years NASA and the Departments of Interior, Agriculture, Commerce, and other agencies have been enthusiastic about the great potential value of data that can be collected from space. Hitherto, we have been limited by budgetary constraints to experimentation on the ground and from aircraft, sensor development, and studies of satellite systems. This work has progressed to the point where we are now ready, if this budget recommendation is approved, to carry out work from space which will enable us and the cooperating "user" agencies to assess with hard experimental evidence the utility of Earth resource data collected by satellites, and begin to develop plans and systems for utilizing such data in their operations. I foresee Earth resource satellite developments in the second decade of space that will parallel and ultimately go beyond the great values that have been realized through the development and utilization of meteorological satellites in the first decade. ERTS A and B correspond to the first experimental meteorological satellites and should have the same revolutionary impact on the many disciplines in the Earth resource field as the original TIROS experiments had in the field of meteorology and weather forecasting.

2. *NERVA flight weight engine development.*—Under the reduced budget level for fiscal year 1969 imposed on NASA under the Revenue and Expenditure Control Act, we were not able to begin in fiscal year 1969 development of the NERVA flight weight nuclear engine as approved by the Congress. Initiation of this development has now been

approved in the fiscal year 1970 budget. By the end of fiscal year 1969 we will have reached the point beyond which it would be impractical, from a technical or program standpoint, to proceed with further preliminary development and test work on the NERVA engine without a clear decision to proceed with actual development of the flight weight engine. This is perhaps our longest term future major technological development effort, and I hope that the total NASA budget level that emerges from the authorization and appropriation cycles in fiscal year 1970 and future years will be such that we are able to sustain the continuation of this very promising development to completion.

3. *Planetary explorers.*—The third new program in the fiscal year 1970 budget calls for the start of a series of small but significant “planetary explorers.” On flights to Venus starting in 1972 and later to Mars, they will fill a vital gap in our program to explore the planets, and allow us to use our larger and more costly Mariner-class missions for only those experiments which require this class of spacecraft. We will find that in the field of planetary exploration, as in the scientific exploration of space around the Earth, the greatest progress can be made at the least cost through a balance of small relatively unsophisticated explorers and the larger more complex spacecraft with sensors and instruments embodying the most advanced technology available.

In all other respects, the fiscal year 1970 budget must be regarded as a “holding” budget which does not set and support new goals for the Nation’s space program to replace those we have achieved or are now close to achieving in the first decade of space.

This is especially true in the important area of manned space flight. As the committee knows, NASA has felt and expressed the need for several years now for clear decisions and support for future manned space flight objectives. We believe that it is clear that the future goals in a balanced manned space flight program lie in two directions: one is continued exploration of the Moon, the other is the development and utilization of a permanent manned space station in Earth orbit. In his decisions on the NASA fiscal year 1970 budget, President Johnson specifically deferred to President Nixon’s administration decisions on both of these goals and on the initiation of new programs to work toward them. Under the fiscal year 1970 budget before you, it will be NASA’s task to proceed with studies of possible future programs and to do everything we can to preserve until fiscal year 1971 effective options to proceed in either or both of these directions.

As Dr. Mueller will discuss in more detail, in manned space flight the fiscal year 1970 budget provides for continuing the Apollo program at a decreasing level and for continuing work toward the single set of flights of the Saturn I Workshop and Apollo Telescope Mount now scheduled for 1971 and 1972. Beyond that, it provides only funds for study—\$11 million for studies of equipment required for future exploration of the Moon and \$9 million for studies and related preliminary work in the Earth-orbital space station field.

Turning for a moment to the U.S.S.R. program, I think it is now abundantly clear that the Soviets are proceeding in manned space flight programs directed both at sending men to the Moon and at substantially enlarged and extended manned operations in Earth orbit.

They have specifically stated that their Zond 5 and 6 unmanned circumlunar flights last fall, in which the spacecraft were returned to Earth, are part of their preparations for manned lunar flight. We have no reason to doubt them. Their automatic rendezvous and docking flights with Cosmos 186-188 and 212-213 and the manned Soyuz 4-5 mission in January, with manned docking and crew transfer, demonstrated their capability for increasing Earth orbital operations and point to future potential for assembly in Earth orbit of both space stations and manned spacecraft to send to the Moon or beyond. In their planetary program, the Soviets have launched two spacecraft to Venus which they say are intended to soft-land instruments on Venus much improved over those of Venera 4 last year. In other categories of space and aeronautics, their program continues to be active and their entire effort is clearly receiving a continuing high level of support.

As indications of future Soviet direction and pace become clearer and as this Nation approaches the first manned Apollo lunar landing, it is clearly appropriate for the new administration and the Congress to take a fresh look at long-term U.S. goals in space. President Nixon has asked me as Acting Administrator of NASA, the Secretary of Defense, and the President's Science Adviser, each to develop proposed plans on the direction the U.S. space program should take in the post-Apollo period and to meet together as a task group under the chairmanship of the Vice President, to prepare for the President a coordinated space program proposal. The task group is meeting this week to begin to consider the problems and opportunities the Nation has in space now and in the next decade. In this planning process, the President has asked that the members of the task group consult, as appropriate, with the State Department, AEC, and other executive agencies concerned, and with the Congress. I have great expectations that through this process will come the badly needed firm decisions for a new program in space and aeronautics of which the Nation can be proud.

Let me conclude by outlining my own views on the goals in space and aeronautics toward which the United States should move in the next decade. I believe that these should include:

First. We should do all we can to understand and put to early use the promise of space for people here on Earth. We should increase our scientific knowledge of the vital Earth-Sun relationship and study the Earth itself from space. We should develop and experiment with new and improved practical applications of satellites, particularly in Earth resources. We should continue to foster the prompt introduction into the economy of new and improved space applications and technology.

Second. We should follow up the first Apollo landings with a sound and carefully planned program of manned lunar exploration.

Third. We should proceed with the development and experimental operation in Earth orbit of a large permanent U.S. space station that is planned for evolutionary growth over the decade, together with a low-cost Earth-to-orbit shuttle system.

Fourth. We should move out steadily in the exploration of deeper space, exploring the planets with unmanned probes of the sun, stars, and galaxies from orbital observatories outside the atmosphere.

Fifth. We should provide the technology for maintaining international leadership for the United States in both civil and military aeronautics.

Sixth. We should maintain a strong momentum of broad scientific and technological advance in all aerospace and related disciplines.

I hope that this year and in the years to come, the committee and the Congress will support the programs and budget requests required to meet these goals.

The CHAIRMAN. Thank you very much, Doctor.

As I announced, for those of you who were not here at the time, we will not have any questions until after the three witnesses have made their statements, in the interest of time.

The next report is from Dr. George E. Mueller, Associate Administrator, Office of Manned Space Flight.

(The biographical sketch of Dr. George E. Mueller is as follows:)

DR. GEORGE E. MUELLER

Dr. George E. Mueller (pronounced "Miller") is Associate Administrator for Manned Space Flight, National Aeronautics and Space Administration. He assumed direction of NASA's manned space flight program on September 1, 1963. In this capacity he is responsible for the planning, direction, execution, and evaluation of NASA's overall manned space flight program. These functions include management authority over the George C. Marshall Space Flight Center, Manned Spacecraft Center, and the John F. Kennedy Space Center.

Dr. Mueller was born in St. Louis, Mo., on July 16, 1918. He received a B.S. in electrical engineering from the Missouri School of Mines in 1939 and an M.S. in electrical engineering from Purdue University in 1940. He was awarded a Ph. D. in physics from Ohio State University in 1951.

Following graduation from Purdue, Dr. Mueller joined the Bell Telephone Laboratories where he conducted television and microwave measuring experiments. He pioneered there in the measurement of radio energy from the Sun, in microwave propagation, and in the design of low-field magnetrons. While employed in Holmdel he continued graduate studies at Princeton University.

In 1946, Dr. Mueller joined the faculty of Ohio State University as assistant professor of electrical engineering. In 1952, he was appointed professor of electrical engineering. His research at OSU included the study and design of broadside and end-fire dielectric antennas, cathode emission, low-field magnetrons, and traveling wave tubes. He designed and developed one of the first 6-millimeter traveling wave tubes and a scanning scintillometer for mapping radioactive iodine.

Before joining NASA, Dr. Mueller spent 5 years with Space Technology Laboratories, Inc., Redondo Beach, Calif., serving successively as director of the electronics laboratories, program director of the "Able" space program, vice president of space systems management, and vice president for research and development.

While at Space Technology Laboratories, Dr. Mueller had overall responsibility for the design, development, and testing of the systems and components basic to the Atlas, Titan, Minuteman, and Thor ballistic missile program; for the development of the United States first successful space probe, Pioneer I; for several other space projects including Explorer VI and Pioneer V; and for the establishment of the U.S. Air Force SPAN satellite tracking network.

Dr. Mueller was one of the originators of the concept and design of the Telebit digital telemetry system. He holds seven patents in electrical engineering and is the author of more than 20 technical papers. With E. R. Spangler, he is the coauthor of a book, "Communications Satellites."

Dr. Mueller is a member of the National Academy of Engineering; a fellow of the Institute of Electronic and Electrical Engineers; a fellow of the American Institute of Aeronautics and Astronautics; a fellow of the American Physical Society; a fellow of the Royal Aeronautical Society; and an honorary fellow, British Interplanetary Society.

Dr. Mueller and his wife reside in Washington, D.C. They have two daughters, Karen Hyvonen, who resides in Germany, and Jean of the home address.

STATEMENT OF DR. GEORGE E. MUELLER, ASSOCIATE ADMINISTRATOR, OFFICE OF MANNED SPACE FLIGHT, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. MUELLER. Mr. Chairman and members of the committee, for the sixth consecutive year, it is my honor and privilege to present to this committee a report of NASA's manned space flight activities in the past year, and plans for the fiscal year beginning in July.

It is particularly satisfying to me, and I know it must be to members of the committee, to look forward this year to accomplishing the national goal established in 1961. The Apollo lunar mission will have much significance for our country's position in the world, for our national unity and pride, for science, for exploration, for technology, and for national security. But for members of this committee, I feel sure there will also be very personal satisfaction. The country and all of us are in debt to you for the support you have given to the achievement of this goal toward which hundreds of thousands of persons in industry, the scientific community, the Department of Defense, other Government agencies, and NASA have worked over a decade.

We must keep in mind, however, that the road leading to success is narrow indeed, and it is bounded on both sides by potential problems, frustrations, and occasionally the possibility of catastrophe. The remaining missions of the Apollo program are the most complex operations we have ever undertaken in space, and the lunar module has yet to demonstrate its operational maturity. Thus we cannot predict at this time exactly which flight will achieve the first Apollo lunar landing mission, but it does seem reasonable to say that success is now within our sight.

It seems appropriate to repeat again the statement of Apollo objectives. The central purpose in this program has been and is the development of the capability for carrying out manned space flight activities in all areas between the Earth and the Moon including landing men on the Moon and returning them safely to Earth. The lunar landing mission itself and the historic beginning of lunar exploration constitute the demonstration of this national capability.

In the light of this objective, I must bring to your attention the fact that the budget for fiscal year 1970 requires a decline in manned space flight program activity—and thus in our continuing development of capability—for the fourth successive year. Because of the relentless pressure of other national needs, the erosion of the national capability for manned space flight continues apace.

The budget before you calls for completing the Apollo and Apollo Applications programs in 1972. Production will be complete for Saturn launch vehicles in 1970 and for Apollo spacecraft in 1971. No funds are provided for implementing a follow-on program. Thus there will be at least a gap in manned flights in the civilian program after 1972.

In this statement, I plan to discuss the reasons why we as a nation need to progress in space, the present status of the manned space flight program, our plans for the future, how we propose to get there, and the funding requested for fiscal year 1970.

Historically, the first and still perhaps the most significant reason for this Nation's need to progress in space is competition—competition on a worldwide basis and on several different fronts. The enthusiasm

resulting from recent successes should not blind us to one aspect of this competition. The Soviets are continuing to devote a greater share of their gross national product than this country to the investment in space and other forms of research and development. Thus the competition for preeminence in space appears certain to continue, and we can expect important demonstrations of Soviet capability in the years to come.

Progress in space stimulates us to increase the development of our total national capability. The visible results of the space program are taken by others as a basis for judgments of the technology and management strength of the nations of the world. Thus the competition contributes to shaping the world of the future and our country's role in that world.

Still another aspect of progress in space is the advantage it gives us in the race for the development of new technology, which is a dominant factor in the economic competition among the industrial nations of the world.

For my part, I see nothing wrong with competition; it has been an energizing force in our free enterprise society. I believe we should welcome the opportunity to continue these efforts to demonstrate whether our society or another is at the forefront of science and technology. Indeed, we dare not allow our Nation to fall behind.

But there are other benefits accruing to the Nation from our activities in space. We are making progress in aeronautics, in lunar and planetary exploration, in space science, in astronomy, in such useful applications as communications, weather observation, navigation and geodesy, and in the utilization of space technology here on Earth. I would like to mention a few direct benefits that have emerged from our efforts in manned space flight.

Pictures taken by our Gemini and Apollo astronauts revealed heretofore unrecognized Earth features of interest to the geological and meteorological communities. Here is a picture of the Los Angeles area, taken on the Apollo 7 mission, which is significant to the control of air pollution. (SA69-515) I understand that Mr. Jaffe plans to discuss this picture in his testimony before Mr. Karth's subcommittee.

Many fields have been stimulated by our space program, for the program involves not only science and technology but also almost every form of ordinary business and professional activity. More than 2,750 of these technological advances have been shared with industry through the NASA technology utilization program. Computer technology, power conversion systems, structural testing, and fabrication techniques, as well as management systems, are benefiting directly as a result of our space efforts. There are new products and new processes, new companies and whole new industries. For example:

The requirements for a worldwide communications network demanded major improvements in the state-of-the-art of computer technology. The computer complex that handled the Mercury flights performed 1 million calculations a minute. Today's Apollo (MC69-4495) system handles 50 times that many—50 million a minute—80 billion a day. The total NASA complex of more than 600 computers now comprises the largest automatic data processing system in the world. This ability to understand and utilize a large computing complex gives the United States a tremendous competitive advantage in solving the problems facing our Nation today.

EARTH RESOURCES SURVEY AIR POLLUTION OVER LOS ANGELES BASIN

APOLLO VII PHOTO



OCTOBER 12, 1968

AIRCRAFT SURVEY OF SULFUR DIOXIDE



MAY 23, 1968

LONG BEACH

POLLUTION HAZE

NASA SA69-515
(Rev.1) 3-10-69

HOUSTON DURING APOLLO 8 MISSION



The need for fireproof materials in Apollo spacecraft has demanded a complete testing and documentation of the flammability characteristics of hundreds of materials. These results have been computerized and are available in industry. Information on flammability of materials developed for Apollo has been passed along to the aircraft industry for its use in outfitting future aircraft. Fireproof Beta cloth developed for space suits is being evaluated for firefighter suits in municipal fire departments.

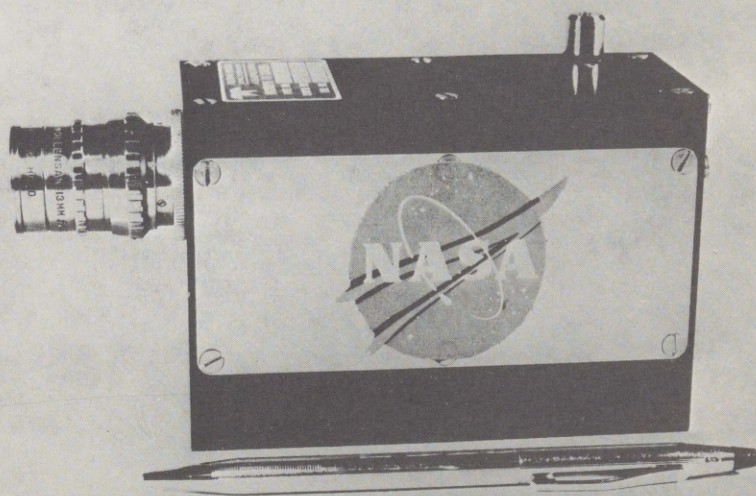
An ultraminiature television camera (MC69-4488) developed for NASA measures twenty and a quarter cubic inches in volume, yet is capable of transmitting images with a resolution conforming to conventional industry practice. With such a device, television techniques are available for many new applications in business, education, and the management of large enterprises.

An ultrasonic hand tool (MC69-4489) is being developed for inspection of spot welds to assure the quality of metal work in the Saturn launch vehicles. It can be adapted for the inspection of bone and density so that an orthopedic specialist might make such determinations without surgery or X-rays.

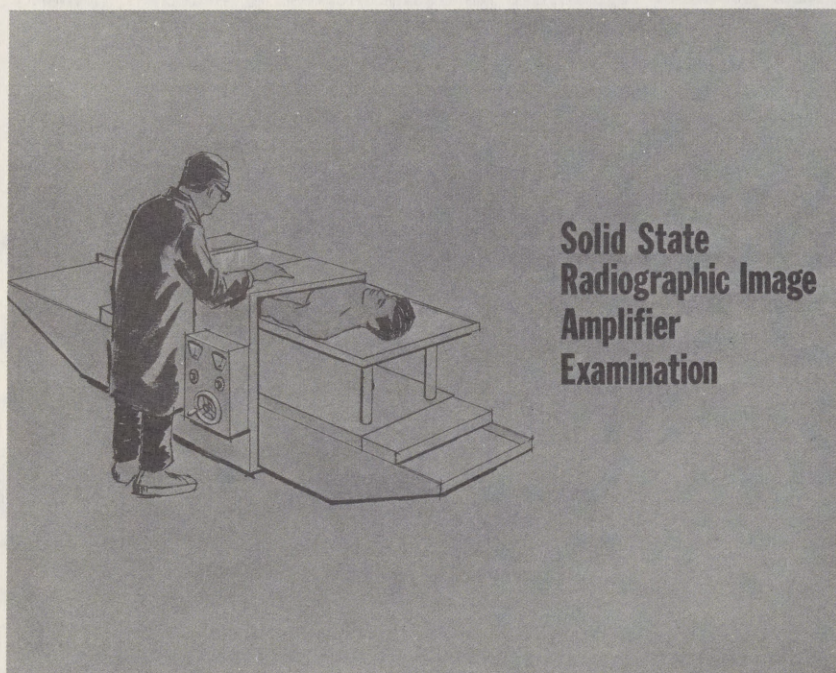
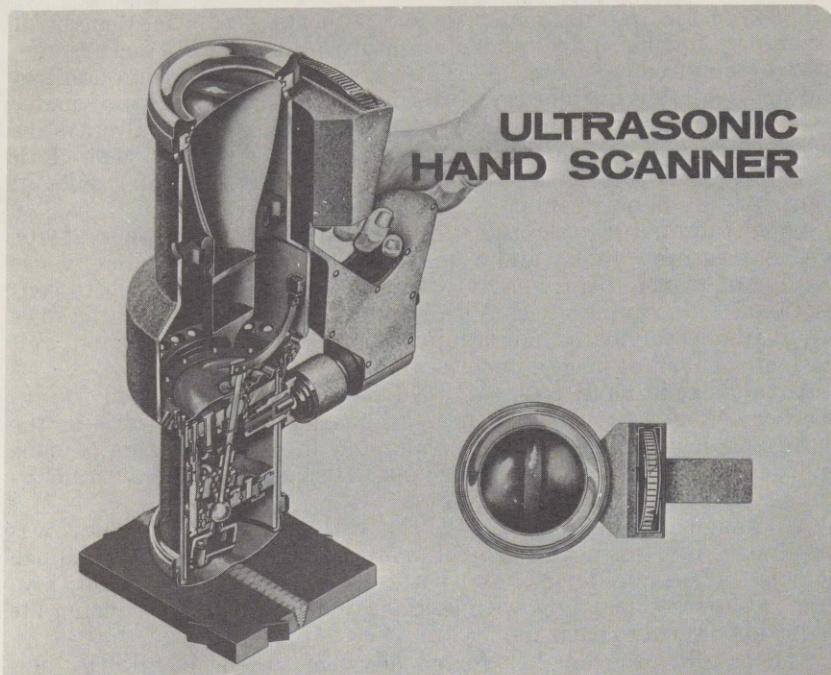
An image amplifier (MC69-4490) with increased efficiency was developed for testing structural materials for the Saturn launch vehicles. The same device, used with medical X-ray equipment, produces a satisfactory image with less X-ray intensity, thus reducing the radiation hazard to patients.

The Apollo program has forced advances in the metallurgy and heat treating of titanium. Information provided by NASA has helped a steel producer to improve its ultrasonic testing practices, a metal

ULTRAMINIATURE TELEVISION CAMERA



NASA HQ MC69-4488
3-3-69



powder production company to improve its control of particle size and product purity, an Ohio firm to solve a problem in high temperature electrical insulation, a Nebraska company to solve problems in welding and galvanizing, and a manufacturer of rubber components to solve lubrication difficulties in a high temperature pressure transducer.

The direct economic impact of the space program is quite obvious. Not so obvious, but of perhaps greater importance in the long run are the basic contributions of the program in bringing together people from all disciplines—from medicine and the life sciences, through physics, astronomy, and engineering to economics and public administration—and causing them to work together toward a common goal—the long-term survival of men in space. I believe that this forced intermingling of various fields of knowledge and skills has done much and will do more to create new solutions to many of our immediate as well as long-term social and urban problems.

Still another effect of the space program is in the form of community and regional progress in the areas of the country in which the program is being carried out. This is particularly true in the areas surrounding the Government installations responsible for management of the manned space flight portion of our program.

The upgrading of the total community is particularly noteworthy in regions such as southern Mississippi, northern Alabama, the New Orleans area, central Florida and the areas southeast of Houston. It seems to be a clear analogy albeit in reverse, to the social changes resulting from the movement of unskilled and semiskilled workers to aircraft factories in World War II. Here we have in effect moved the factories to these communities.

At the time, many of the industrial and military experts reacted in disbelief when President Roosevelt set for the United States the staggering goal of producing 50,000 aircraft per year. Yet the Nation not only achieved that goal, but surpassed it. In the process, great social changes occurred as displaced subsistence farmers were trained to build airplanes and other weapons of war. When the war ended, these people continued to use their new skills. They did not return to subsistence farms.

The economic effects of the space program are spreading throughout our society. Everywhere, it has widened our horizons. Its energizing force permeates our economy. It is a seedbed for invention, a stimulus to higher productivity and a taskmaster for precision and reliability.

The question is often asked today as to why we should spend money on space and other programs of technological development when at the same time the Nation has needs related to poverty, the cities, transportation, and the maintenance of clean air, water, and other elements of our environment. This is a question that certainly deserves a thoughtful answer.

I am among those who believe that we can and should do more to meet these needs of man on Earth. I believe also that we must take the measures necessary to assure that our economy continues to grow as it has been growing in recent years. For it is only through growth in our productivity, based on the knowledge derived from the advancement

of technology, that we can create the wealth necessary to solve the problems of our times. We need to provide both for technology advance and human needs. We have seen that the space program has contributed directly to improving our life on Earth. But there is much more to be gained than the creation of the facilities and communities devoted to space flight. Our national growth and every facet of our life on Earth is affected, enriched, and improved by the adventure and the fact of space flight.

Now let me turn to the status of the program. The successful results of the Apollo 7 and Apollo 8 missions have verified that the technical and management maturity of the Apollo program is acceptable. They have also restored momentum to the manned space flight program and substantially increased our confidence that the Apollo lunar mission and safe return of the astronauts will be achieved in 1969. To obtain maximum benefit from the space vehicles of the Apollo program, we have worked out plans for a period of lunar exploration following the first lunar landing with flight missions at a rate of between two and four a year.

The flight of Apollo 11, currently scheduled for summer, will be the first opportunity to accomplish the Apollo lunar landing mission.

On subsequent landing and return missions, it is planned that the astronauts will emplace on the lunar surface the Apollo lunar surface experiment package (ALSEP), a sophisticated set of devices with a nuclear isotope power supply.

As you know, the scientists of the world are eagerly awaiting the results of this initial manned exploration of the Moon. A thorough exploration plan has been evolved by the scientific community which will be initiated with the remainder of the 15 Saturn V launch vehicles and Apollo spacecraft available under the Apollo program.

Three initial phases of lunar exploration have been defined. The first phase will consist of landings that sample and observe the major classes of regions on the Moon. To establish these norms, it will be necessary to land, carry out geological prospecting, and obtain rock and soil samples for return to Earth from four separate sites. These include two types of lowlands or maria and two classes of highlands.

The second phase would include the investigation of the major classes of lunar anomalies. We would prospect and obtain samples from volcanic types, sinuous riverlike channelways, fracture zones, and impact craters. Six additional sites have been identified as the minimum to be explored to provide answers to the basic questions about the Moon and to evaluate locations of potential resources, building materials, or underground shelter openings.

The third phase would be to tie together this information from 10 or more sites by making a remote sensing survey of the Moon from lunar orbit.

Following the completion of these three phases and a thorough assessment of what has been learned, we would have the knowledge necessary to proceed to a decision as to the value of building up our capability at a single location on the Moon by revisiting the same site. This in turn would permit us to determine the desirability of semipermanent or permanent operation of a lunar station with observatory and research facilities.

The program before you for fiscal year 1970 calls for three additional lunar missions in the year following the first landing. This makes it possible to proceed through the first phase of establishing lunar norms and emplacing the initial network of ALSEP stations. It does not provide for the meaningful utilization of the remaining Apollo space vehicles after fiscal year 1970.

In Apollo Applications, the budget for fiscal year 1970 provides for a continuation of flight hardware development and for integration of modified subsystems into hardware for a set of five Earth-orbital flights. Plans call for the first flight of the Orbital Workshop late in 1971, followed by a revisit mission later in that year and the Solar Astronomy mission in 1972. These important uses of the Apollo equipment will permit us to lay a solid foundation for the design of a space station, which is the next major step in the development of our space capability. However, like the Saturn V lunar exploration program, the completion of the currently authorized Apollo Applications flights in 1972 terminates the manned flight activity until other manned flight programs are established.

As we approach the lunar exploration phase of the Apollo program and the operational phase of our utilization of Apollo capability in the Apollo Applications program, we must focus on the direction of the space activities of the middle and latter 1970's.

In my judgment, the future of manned space flight is clearly dependent on the degree to which costs can be reduced. In recent years, substantial progress has been achieved in engine technology, in lifting bodies, and in systems design. These advances have created an opportunity to develop reusable space vehicles. As the committee knows, unlike any other form of transportation, all present U.S. space vehicles are discarded after a single flight. Through reusability, it would appear that very substantial reductions in space flight costs can be achieved over the period of the next 5 or 6 years.

Such cost reduction would have a major impact on the space program. On the one hand, it would permit us to do more with available funds in scientific investigation, exploration, extension of manned flight capability, and development of practical applications. On the other hand, it would make it possible to take advantage of the presence of man in space to supervise, check out, and maintain experimental equipment and unmanned satellites. If the transportation cost can be reduced substantially, man's use will increase and eventually it will be less expensive to use man than to design and manufacture complex machines to replace him.

Under present technology, the Saturn IB, Titan III, and Saturn V launch vehicles can be employed to place payloads in low Earth orbit at costs in the range of \$500 to \$1,500 a pound, depending on production and launch rates. The very large payload capacity of the Saturn V—about a quarter million pounds—enables it to achieve the lower limit of this range.

However, in order to improve the cost picture markedly, new space transportation concepts are being studied. These are based on newly emerging technology, with emphasis on operational simplicity. By the middle 1970's, these can result in cost reductions of a factor of 10 or more. With the maturing of operational experience later in the

decade, even greater cost reductions can occur—just as they did when jet aircraft were introduced into the airline business.

This cost reduction should bring about other corollary benefits. At present, the costs are also very high for equipment designed for use in space. To some degree, this results from the demands of the space environment. But in addition, very high reliability standards—much higher than those on earth—must be met by such equipment. If reduced transportation costs could permit planning on maintenance, repair, and replacement of parts and components, it might well be possible to reduce substantially the original equipment costs. In addition, they would permit use of heavier equipment with greater design margins, thus allowing a reduction in the amount of costly testing of space flight equipment.

We have over the past years, through several joint bodies, carefully coordinated all aspects of our space program with the Department of Defense and other agencies of the Government. We are placing particular emphasis on coordination of our plans for the space station and low cost transportation. We are working closely through such mechanisms as the Manned Space Flight Experiments Board and the Manned Space Flight Panel of the Aeronautics and Astronautics Coordinating Board. A substantial number of persons representing the military services participated in the space station technology symposium held at the NASA Langley Research Center February 11 to 13.

Now I would like to discuss how we would if we could propose to move out toward accomplishment of our plans for manned space flight activities of the middle and later 1970's. The forward progress of our space technology has brought us to the point where we will be ready to place man into space for more extensive periods of time. We are also prepared to increase greatly his productivity in space. Experiments being devised will seek to benefit man on Earth through better knowledge of our own planet as well as of our solar system. Additional experiments would take advantage of the vacuum and zero gravity of outer space to conduct tests not possible here on Earth.

To do these things, our astronauts require a workshop or laboratory in space that gives them a place in which to conduct these essential experiments. In conjunction with this workshop, they also require a habitat capable of supplying their life support needs for months at a time. The logical answer to these requirements is a semipermanent space station.

If approved, our initial step in the construction of such a station would be to design a series of modules, each capable of supporting certain functions of the space station, and each capable of being attached to the other modules. One module would serve as a workshop, another could contain the living quarters, still others would supply necessary food, oxygen, and other life-sustaining items. In its early years, the station would be a relatively small assembly of modules, but it would have the capability to grow in size as requirements increased.

We believe such a space station system could and should be in being by the mid-1970's. Funds requested for fiscal year 1970 will permit the continuation of definition studies, preliminary design, engineering, and supporting work.

The viability and success of long-duration space station flight programs are critically dependent on the availability of a cost effective and versatile round-trip transportation system. Our studies have shown

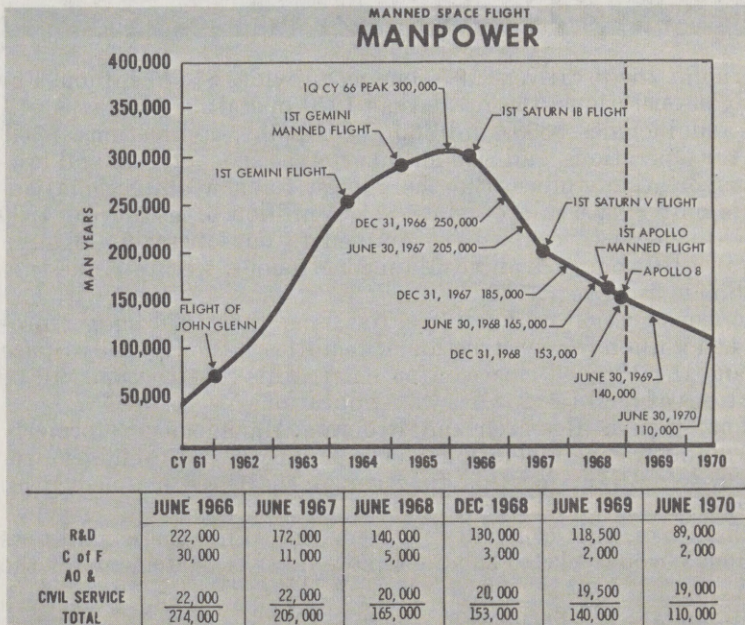
that a low-cost reusable shuttle system will provide the most economical means of space station support. Therefore, our plans call for the development of a space shuttle in parallel with the space station. Logistic systems for personnel rotation, expendables resupply, and experiments and experiment module delivery represent a major share of the manned Earth orbiting space station flight program costs. Past and present planning studies conducted by both the Department of Defense and NASA unanimously underscore the importance of and the need for such a manned round-trip Earth orbital transportation system, which is both more operationally effective and more cost effective.

In addition, we propose to continue in the advanced manned missions program with studies aimed toward manned flight activities beyond the initial exploration activities in Earth orbit and on the Moon. Studies proposed for fiscal year 1970 continue our work in the areas of astronaut rescue and escape, advanced lunar exploration, and the identification of advanced mission requirements and operational modes following the initial space station operations.

Now let me turn to the cost of all these activities in fiscal year 1970.

For the three manned space flight research and development programs—Apollo, space flight operations, and advanced manned missions—we propose a total of \$2,007.7 million for fiscal year 1970. Thus the total for all of manned space flight R. & D. is less than the amount Congress authorized for Apollo alone in fiscal year 1969.

Our request for fiscal year 1970 is 40 percent less than the total we received in fiscal year 1966. During these 4 years, because of general inflation and because of the recently negotiated labor settlements in the aerospace industry, we estimate that the cost to NASA of obtaining goods and services increased by about 20 percent.



The decrease in our funding is reflected in a corresponding decline in our manpower. With this request, by June 1970, employment on the manned space flight program is expected to be only about one-third of the 300,000 employment peak that was reached in February 1966. This chart (MC69-4410) illustrates the manpower decline.

The next chart (MP69-4380) summarizes our funding requirements.

**MANNED SPACE FLIGHT
FY 1970 AUTHORIZATION REQUEST
(MILLIONS OF DOLLARS)**

	FY 1968	FY 1969	FY 1970
RESEARCH & DEVELOPMENT	<u>\$2809.2</u>	<u>\$2177.5</u>	<u>\$1890.2</u>
APOLLO	2556.0	2025.0	1651.1
SPACE FLIGHT OPERATIONS	253.2	150.0	236.6
ADVANCED MISSIONS	-0-	2.5	2.5
CONSTRUCTION OF FACILITIES	<u>\$21.3</u>	<u>\$104</u>	<u>\$14.2</u>
RESEARCH & PROGRAM MANAGEMENT	<u>\$315.1</u>	<u>\$312.0</u>	<u>\$307.5</u>
TOTAL	\$3018.6	\$2626.9	\$2211.9

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For Apollo, the fiscal year 1970 budget provides \$1.651 billion. For space flight operations, the fiscal year 1970 operating plan is \$354.1 million and includes \$308.8 million for Apollo Applications, \$36.3 million for Operations, and \$9.0 million for the space station and low-cost transportation studies. But the request for new obligational authority is only \$236.6 million since \$117.5 million of fiscal year 1969 funds withheld last year will be applied to our operating plan in fiscal year 1970. For Advanced Manned Missions, we are requesting \$2.5 million in fiscal year 1970.

In the Construction of Facilities, the fiscal year 1970 budget provides \$14.24 million for construction of facilities at the Kennedy Space Center and the Manned Spacecraft Center. This construction will be modifications of facilities for Apollo Applications.

The final item is Research and Program Management (formerly called Administrative Operations). The fiscal year 1970 budget provides \$307.45 million for this function at the three manned space flight field centers.

Mr. Chairman, this concludes my remarks. With the committee's permission, I would like to submit a more detailed statement for the record.

The CHAIRMAN. The permission will be granted.

(Dr. Mueller's complete prepared statement will be found in the Manned Space Flight Subcommittee hearings.)

The CHAIRMAN. I will call on Mr. Lundin at this time.
(A biographical sketch of Bruce T. Lundin is as follows:)

BRUCE T. LUNDIN

Bruce T. Lundin is the Deputy Associate Administrator for Advanced Research and Technology at NASA Headquarters, Washington, D.C. His appointment to the position was effective August 1, 1968.

The Office of Advanced Research and Technology (OART), one of four major NASA program offices, is responsible for the planning, conduct, and dissemination of the results of all NASA aeronautical and space-related research, as well as coordination of supporting research and technology efforts required for specific missions.

As Deputy Associate Administrator, Lundin exercises the No. 2 functional role in overseeing the broadly based scientific and engineering tasks undertaken by OART to assure that the Nation remains at the forefront of advancements in aviation and space.

Lundin came to Washington from the NASA Lewis Research Center, Cleveland, Ohio, where he had been Associate Director for Development and had a distinguished career in aeronautical propulsion and launch vehicle technology. He had directed at Lewis such propulsion and space power generation programs as Centaur, Atlas-Agena, and SNAP-8.

Lundin was born in Alameda, Calif., December 28, 1919. He received a B.S. degree in mechanical engineering in 1942 from the University of California. He began his scientific career with the National Advisory Committee for Aeronautics (NACA) in 1943 at the Lewis Center. When the NACA became part of the National Aeronautics and Space Administration in October 1958, Lundin was appointed Associate Director of the center, directing the organizational aspects and planning required for the center's expanding role in research.

The NASA executive is a member of Tau Beta Pi, Sigma Xi, an associate fellow of the American Institute of Aeronautics and Astronautics, and a fellow of the Royal Aeronautical Society. He is also a member of several governmental advisory committees, including the NASA Aerospace Safety Advisory Panel, the Scientific Advisory Board of the U.S. Air Force, and the NASA Research Advisory Committee on Space Vehicles. In 1965 he was recipient of the NASA Medal for Outstanding Leadership.

Lundin resides in Annandale, Va., with his wife Barbara and three children.

STATEMENT OF BRUCE T. LUNDIN, DEPUTY ASSOCIATE ADMINISTRATOR FOR ADVANCED RESEARCH AND TECHNOLOGY, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. LUNDIN. Mr. Chairman and members of the committee, I appreciate the opportunity to appear before you regarding the part of the NASA fiscal year 1970 budget that supports the program of the Office of Advanced Research and Technology. I will summarize a more detailed statement which I would like permission to submit for the record.

The CHAIRMAN. Approved.

(The complete prepared statement referred to will be found in the Advanced Research and Technology Subcommittee hearings.)

Mr. LUNDIN. This broad program of research and technology, which is carried out in the laboratories of government, universities, and industry throughout our country, provides the basic or enabling technology important to meeting new challenges in aeronautics and space and thus to the future strength of our Nation.

The wisdom of Federal support for aeronautics research and technology is evident in the vitality and rapid growth of air transportation in the past 10 years. This year, domestic passenger-miles will exceed 100 billion, which is four times what it was a decade ago and a third

of what is expected 10 years from now. Air cargo has grown even more rapidly, with a profound impact on our economic life. Most of the jets on the airways of the world are American made. Currently, an \$8 billion backlog for commercial aircraft is on the books, with about a third of it for foreign sales.

The origins of this great national capability are, of course, found in the research and advanced development undertaken in the 1950's, much of it in the laboratories of NACA.

In contrast to this picture of strength, however, it is becoming increasingly evident that our competitive edge at home and abroad is eroding. We are not the first to fly a supersonic transport. Foreign aircraft such as the French Breguet, the German Dornier and the Canadian DeHaviland Otter, are in experimental or regular commercial operation in this country in the potentially great market of short-haul transportation and without competition from American aircraft.

The rapid increase in air transportation born of this prior research has, of course, also brought with it problems along with its benefits. Noise and pollution are major concerns in many of our communities and the air traffic control systems of several of our major airports are reaching the saturation point. It is therefore evident to many of us that now is the time for our Nation to step up its R. & D. efforts to meet these challenges. As in the past, the capabilities that we will enjoy in the future will be directly related to the investment that we make now in the pursuit of the underlying research and technology.

The NASA fiscal year 1970 request for support of aeronautics research has therefore been increased \$14 million, to \$187 million in total funding, continuing the modest growth of the past several years.

Some highlights of the fiscal year 1970 aeronautics program are—

1. To strengthen the base of advanced research;
2. To increase the technology base of short-haul transport;
3. To increase research and technology for aircraft noise abatement and safety.

The increased support of advanced research covers such disciplines as aerodynamics, propulsion, structures, materials, and avionics, as well as providing for the maintenance and upgrading of our valuable and unique research facilities. This is the base or seedbed for innovations that lead to advanced aircraft. An example is the NASA area rule or "Coke-bottle" fuselage shape to reduce supersonic drag that is now part of every American supersonic aircraft design. The supercritical wing, another product of our research, is a recent innovation which holds the promise of increasing speed, maneuverability, and efficiency of subsonic aircraft.

Avionics, the use of modern electronics in the field of aviation, is a relatively new discipline that is playing an increasing and vital role in modern aircraft. Here, also, is a large opportunity to transfer the electronics technology developed for the space program to the problems of aeronautics, such as for collision avoidance and the development of all-weather landing capabilities. For example, the Electronics Research Center is studying the use of proximity-warning devices to avoid midair collisions, and the possibilities of an aircraft-satellite link as a means of communication and navigation over water areas where present capabilities are limited. In the future, this method of

navigation could provide precise position fixing in crowded domestic operations.

In the field of VTOL aircraft, the helicopter is unexcelled where extensive hovering is required. In the past 10 years, helicopter scheduled airlines increased their ton-miles almost sevenfold, lending emphasis to the future potential of this market. The helicopter does, however, contain many inherent disadvantages. It is difficult to fly, and operating life is limited by vibration and fatigue. Our fiscal year 1970 plans, therefore, include research on these problems, as, for example, on jet-flap rotors and on automatic landing systems.

The STOL, or short take-off and landing aircraft, appears to be a most promising type of transport for many commercial operations. Our fiscal year 1970 STOL research effort is concentrated on two types of such aircraft. One is a propeller-driven aircraft with a rotating cylinder at the leading edge of the flap to provide greater life and hence reduce landing and take-off runs. The second type uses a jet engine to pump air over the wing and down a slot in the trailing edge for powered lift. Both of these concepts are planned for investigation through flight tests of modified aircraft as a necessary follow-on to wind tunnel testing.

I am also pleased to report satisfactory progress in our program of noise reduction. Sound-absorbing devices in the inlets of jet engines have been demonstrated at our Langley Research Center and flight tests of commercial-type transports are planned later this year. Engine designs capable of reducing the noise at the source have also been studied at the Lewis Research Center and negotiations are underway with two engine manufacturers for the design, construction, and testing of experimental, quiet engines.

Turning now to space, the benefits from this technology are only beginning to unfold. We already have a worldwide satellite communication network organized and operated as a commercial business. A worldwide meteorological satellite network is being operated by the Environmental Sciences and Services Administration with over 40 countries receiving cloud cover data with their own equipment. We have greatly expanded our understanding of the Earth, its space environment, the Moon, and our neighboring planets. A manned space flight capability has been developed through more than 3,000 man-hours of successful Mercury, Gemini, and Apollo flights capped by the Apollo 8 flight around the Moon last December, and as you have heard this morning, by Apollo 9 which is in orbit now.

As we enter our second decade of space exploration, we face new and expanded technical challenges. We will shortly have completed the Apollo program and flown out most of what may be considered our first-generation spacecraft. Whatever our Nation will undertake in space, it seems clear that it will involve manned operations of longer durations, of landing automated craft on other planets, of beginning to explore the Moon, and of handling vastly increased amounts of data from space. Life-support systems of long duration, and increased propulsion capability, the ability to generate larger amounts of electric power in space, better methods of communication and control, the ability to handle large structures in space, and the broad technology of reducing the costs of space operations, are among these potential

requirements of the future. To provide the technical base that will enable us to move forward in a sound and economical manner is the underlying motive of the OART program of space technology, a broad program totaling some \$312 million.

As we strive to extend the duration of manned operations in space, we must better understand his physiological and psychological response to the stresses and the environment of space flight. We must also learn how to build life-support systems that can operate reliably for several years. These are the complex electrical, mechanical, and chemical systems that provide man with air, food, and water; that remove and treat waste and reclaim water and oxygen, and that maintain a comfortable environment involving the cabin atmosphere, heat, moisture, noise, and motion. In addition, we need the technology that enables the man-machine system to perform at peak efficiency and for equipment that will enable man to move about and work outside of his shelter or spacecraft. Much of this research on man and his supporting equipment is, of course, also the kind of research and the technology that may have far-reaching implications to our everyday lives here on Earth.

Other challenging requirements for reliable, long-endurance equipment exist in the area of space power. All of our future spacecraft, manned or unmanned, will require increasing amounts of reliable electric power. The continued widespread use of solar cell and battery systems gives a high payoff on research to reduce the weight and improve efficiency and reliability of these devices. Nuclear power systems are particularly important for space because of their basic characteristic of long endurance, independent of whether the sun is shining or not.

I am therefore pleased to report that our SNAP-8 program, our Nation's only space nuclear power system underway in the range above 30 kilowatts, has made very good progress this past year. And running time on all major components is now measured in thousands of hours and a complete breadboard power conversion system is now approaching the 3,000-hour mark, including long periods of hands-off operation and a fully automatic start up and shut down. The maturity of these power components and their system now enables us to undertake the next logical step in the development of this important technology—that of combining the nuclear reactor provided by the AEC with the rest of the system for combined system tests in the facilities of the Plum Brook Station of the Lewis Research Center.

With regard to space propulsion, it is pertinent to note that our capabilities in space, as throughout the longer history of aeronautics, has always been paced by advancements in propulsion. An important part of our propulsion research program is therefore aimed at the use of higher energy systems in future spacecraft—following, in a logical sequence of development, the successful use of hydrogen fuel in the Centaur and Saturn launch vehicles. We are therefore learning how to store and handle the extremely cold liquid hydrogen fuel in the space environment for long periods of time. Other parts of this program are investigating the feasibility and possibilities of the “space storable” propellants such as FLOX-methane and oxygen difluoride-diborane combinations.

Beyond the capabilities of these chemical rocket systems lies the potential of the nuclear rocket. With a specific impulse of about twice that of our best chemical systems, and with an inherent capability for high reliability and flexibility of operation, the nuclear rocket may well become a predominant space propulsion system of the future. Our program on nuclear rocket technology, a cooperative effort with the Atomic Energy Commission, has been one of our most successful technology programs.

In the 1964-68 period, reactors and engine breadboard systems have been operated at power levels above 1 megawatt for an accumulated time of greater than 10 hours, including more than 4 hours at high power. The engine system has been started, operated over a range of conditions, stopped, and restarted—all very smoothly. We are preparing to test a complete experimental engine system at our Nuclear Rocket Development Station this month. These tests will essentially complete the technology phase of this effort and we are proposing to proceed with the construction and test of experimental, flight-weight engine systems this next fiscal year. In addition to all of these efforts to increase the efficiency of propulsion, the endurance of power systems, or to better understand the response of man to new environments, a very important requirement ahead of us is to develop the technology for significantly reducing the costs of space operations. While this drive to learn how to produce and operate our space systems in a more economical fashion exists throughout our activities, current attention is, as Dr. Mueller noted, focused on the launch vehicle or logistic supply system.

Present launch vehicles are, of course, based on the missile technology of the 1950's where high performance and reliability were primary goals and cost was secondary. Now that we have reached the performance and reliability goals, we must retain them and, at the same time, reduce the costs of their production and operation.

The path of lower costs contains many elements, depending on the timing requirements, the launch rate involved, and the state of the required technology. One method is to greatly simplify our launch vehicles, and here the demonstrated ability of the solid rocket motor offers a real potential. Remarkable progress in the design and operation of large solid rockets has been made over the past several years, particularly by our military services. Should we desire to undertake the development of a solid rocket system for space use at some future time, however, additional technical developments are required if we are to proceed in a sound manner. We are therefore, engaged in studies of various methods of thrust vector control, of learning how to build reliable and low-cost motor cases and seeking solutions to problems involved in the casting and curing of large propellant grains.

Inherent in low-cost operations is, of course, the prime requirement to bring our astronauts and their expensive equipment back to a landing at prepared locations on the ground instead of effecting a recovery at sea. In this manner, we would not only reduce the high costs of recovery operations, but be able to reuse expensive equipment. It is of importance, therefore, that we continue our program of research, a cooperative one with the USAF, on the characteristic of

lifting bodies of various types. As we projected during last year's testimony, the HL-10 lifting body is now undergoing powered flight tests at our Flight Research Center and the Air Force X-24A configuration will be in the air within the next few months. Data on the stability, control, and handling characteristics of these piloted, wingless bodies are thus coming to hand. Theoretical studies and wind tunnel investigations are also in progress on other, more advanced or versatile configurations and we look to the day when some of our research on the difficult structural and propulsion problems of hypersonic flight may be married to the requirements of truly efficient space flight operations.

As we consider the resources required to carry out this program of research and technology we think, of course, in terms of budgets and dollars. But in a very real sense, our most important resource is people—the skilled and dedicated people of our centers and in the universities and industries of this country with whom they work. To pay the salaries of these men and women of our centers, to pay the power bills of their wind tunnels and other facilities and to provide them with the services that their work requires is the purpose of the part of our budget request entitled “Research and Program Management.” To underscore the importance of this resource, I wish to emphasize that an essential element in achieving the success we have enjoyed in the difficult tasks we undertake is the process of competence in Government joining with competence in universities or industry in a cooperative attack on our problems, technical or managerial. This high level of experience and competence of our centers has been built up and maintained with great care over many years. It stands today as a distinct national resource of large value.

But we enter the fiscal year 1970 with cause for concern and many difficult problems. One of the most important and difficult tasks we face is the balancing of available talent with growing needs in a dynamic environment. The OART centers, the Langley, Lewis, Ames, Electronics, and Flight Research Centers, are responsible not only for the execution of the bulk of the OART program but also for many important programs of the Office of Space Science and Applications and for cooperative programs with or for assistance to many other agencies of the Government.

Of serious concern to us at this time is the overall staffing picture at our centers. Under present personnel ceilings, coupled with an unusually low rate of turnover these past several months, we have been forced into a hiring freeze at our major research centers. In the short term, it becomes difficult under these conditions to preserve the proper skill mix required for effective operation. A concern of larger and deeper dimensions is the inability to bring the fresh, new talent into our centers that is the life blood of any research organization. I therefore urge your full support for the “Research and Program Management” budget so that we can move forward in solving these problems and for the tasks that lie before us.

One final note on a matter of comparable importance. This relates to the tools that are used to give substance to the skill of the minds and hands of our people. Congress has, through the years, wisely provided

for a steady growth in the research facilities of our centers until today we possess a total facility capability that is absolutely unique for space and aeronautical research. The tools with which we work, however, must have a cutting edge against the sciences and technologies pertinent to the times. Two new research facilities are therefore identified and requested in the fiscal year 1970 budget, one for a Computer and Instrumentation Research Laboratory at the Electronics Research Center and a second for an Aircraft Noise Reduction Laboratory at the Langley Research Center. As previously noted, the new science of avionics offers an especially attractive field of research for important advancements in aeronautics. I'm sure we have only begun to see the full impact of the rapidly growing fields of microelectronics and the computer in not only aeronautics and space, but in a very wide range of activities. To provide the workshops and equipment for our people at the Electronics Research Center that they may effectively contribute, in partnership with universities and industry, in this important and new field of research is the purpose of the Instrumentation and Computing Research Laboratory. Fundamental research into not only the physics of noise generation but also into means of its attenuation and suppression and its subjective influence on people has been long neglected. We can no longer continue to approach the growing noise pollution of our environment on an ad hoc, empirical basis. This Aircraft Noise Reduction Laboratory therefore reflects an urgent need to fill a long-neglected field of work.

Taken altogether, this broad and complex program of research and technology, the people who carry it out, and the facilities that they use represents a total endeavor that we believe to be of very fundamental importance to our future. It is, in truth, the stuff of the future, whether it be in aeronautics, in space, or wherever this knowledge and these technologies may find application in the future life of our Nation.

The CHAIRMAN. Thank you very much, Mr. Lundin.

It may be your first time before this committee, but we welcome you and the staff of experts who sit at the table with you, and I will say that you are up to the usual high standards we expect.

Now, gentlemen, the witnesses who have testified are open for questioning, and we will start with Mr. Fulton.

Mr. FULTON. I would compliment you gentlemen on your testimony, but I would criticize that there is nothing said about the solid booster program.

Next, on the administrative budget for last year, if you recall, it was \$648 million, and it was cut on the floor to \$603 million. Your present figure on administrative operations does not correlate with that, it is around a \$650 million figure.

I would also like to compliment you on the progress of NERVA and nuclear rockets, and my question is, is \$36½ million enough for NASA when AEC is spending \$50 million in the same fiscal year?

Another point is on the U.S.S.R.'s SOYAS 4 and 5 in January which flew this year. They, of course, did just about what we are doing in part of the Apollo 9 program. My question is, If they have had this crew transfer in January of this year, suppose we look at the flight to the moon as a football field, Dr. Paine, and we will put Apollo 8 on

the 30 yard line, Apollo 9 on the 20 yard line, Apollo 10 on the 10 yard line, and then the goal of Apollo 11. Where are the Russians compared to that on their program for moon landing?

Dr. PAINE. Mr. Fulton, as you recall, the Soviets fired three ZOND probes to the moon, Zond 4 is rather unknown to us, but 5 and 6 successfully circumnavigated the moon. We know too the rendezvous techniques you have mentioned have been successfully carried out—

Mr. FULTON. But what line do you put them on?

Dr. PAINE. If I took all of the activity we see, as sort of a personal judgment, I would say just before they turned the lights out on the stadium, they were on about the 50-yard line, but since our program is so open and theirs is closed, it is difficult to be more precise.

Mr. FULTON. What is your educated guess now?

Dr. PAINE. I would guess about the 50-yard line, but this might have to be radically changed in the next few months.

Mr. FULTON. Then with this current flight, are we then currently 20 to 30 yards ahead?

Dr. PAINE. If we are successful in carrying out the activities planned by the end of this week, I think we will be approaching the end of our lunar landing period, and I think your characterization placing us at the 20-yard line is a rather good one.

Mr. FULTON. I am always interested in how NASA is able to operate without an inspector general when one is required by the Air Force, either NASA is proving the Air Force doesn't need one, or the Air Force is proving that NASA needs one. You can put that in the record later.

(Information requested is as follows:)

Instead of creating an office of Inspector General within NASA, the functions of such an office are performed on a continuing basis by established groups such as the Audit Division, the Personnel Division, the Inspections Division, and Office of the Director of Safety. Indeed, the basic NASA organizational structure and management processes provide for checks and balances and multiple communication channels to assure visibility, at all levels, into NASA operations and any actual or potential problems.

In addition, ad hoc groups are appointed from time to time to review specialized areas such as manpower utilization, etc. NASA also uses ad hoc panels of experts for situations which do not warrant continued appraisals. The accident review boards which are established to investigate each serious accident are typical of these types of specialized groups.

In NASA's view, this pattern of operation, including formal and ad hoc reviews is more effective, and better suited to the type of activities in the NASA program, than would be the establishment of a formalized office of Inspector General. The functions performed by the Inspector General in organizations such as the Air Force, which have large bodies of men and which act through numerous agents, are different from the functions performed in the formal and ad hoc reviews by experts within NASA.

In summary, it is NASA's view at the present time that the reviews, inspections, and evaluations within the NASA programs are best carried out, at the least cost, under the systems which are now in effect.

The other point is on the NERVA program. In 1969 it is 32 million and the 7½ million carryover, making it 39½ million for the current budget year. You are reducing it to 36½ million. Is that enough when you consider the reduction there? You can put that on the record later.

(Information requested for the record follows:)

The amount of \$36.5 million requested for the nuclear rocket program in fiscal year 1970 will allow a moderately paced program geared toward minimum reasonable progress in the development of the NERVA flight weight engine. It is true that the total nuclear rocket program budget in fiscal year 1970 is actually

less than the amount effectively available for fiscal year 1969 (considering the application of the \$7.5 million deferred from fiscal year 1968). However, it should be noted that significant reductions have been made in the program in fiscal year 1969 limiting the progress that can be made. As one of the consequences of these reductions, there will be a hiatus in testing following the conclusion of the XE experimental engine test series this summer with an attendant reduction in the funding devoted to testing. The fiscal year 1970 budget is compatible with these circumstances.

One other point is about the Apollo applications program. I believe the name should be changed. I am tired of classicists who are misdirected. The Apollo program is a moon program but Apollo is the sun god. It should be Diana. So let's stop the classics system and turn to the type as they did in aeronautics. I think we would now talk of space planetary exploration, moon exploration, moon development, then you can have a number after that, and a number after Mars, for example, instead of calling it Mariner Mars, call it Mars 4 and then give the booster, and Saturn 5. If you would have a simplified designation I think the public would be more expertly informed than having experts talking all this neoclassicism. So I would suggest you use new names, why don't we call it planetary exploration program, you can call it PEP, something new.

If we gave you \$117½ million more, could you put in the record how you could spend that productively?

(Information requested for the record follows:)

The question as to productive expenditure of an additional \$117.5 million of budget authority in fiscal year 1970 involves matters of overall balance of programs within the executive branch and within NASA. Should the Congress and administration find that additional resources can be made available to NASA, the determination of where and how to apply them would be contingent upon a clear definition of our national space goals and objectives and the application of specific priorities. The President has established a task group chaired by the Vice President and consisting of the Secretary of Defense, the Administrator-designate of NASA and the President's Science Adviser to develop recommendations on these very issues. While final decisions would be dependent on the results of the deliberations of this group and final decisions of the President, we can outline the major areas of NASA's activities which would be involved in almost any discussion of these issues and which, with the application of additional funds, would be outstandingly productive.

One urgent area for attention would be manned space flight where decisions were specifically deferred to President Nixon's administration. The fiscal year 1970 budget does not support future manned space flight objectives beyond those currently underway and scheduled to be completed in 1972. We are convinced that the future goals in a balanced NASA program should include continued exploration of the moon and the development and utilization of a permanent manned space station in earth orbit coupled with a low-cost space shuttle logistic system.

For lunar exploration, the current budget includes fiscal year 1970 funds required to achieve a manned lunar landing and to conduct several additional Apollo-type missions to the moon using Apollo hardware. Scientific exploration equipment is available for only three flights after the first lunar landing attempt. No provision is made for development of equipment required to achieve extended lunar staytimes, shelter, and mobility for extended exploration to the moon. Without making provision for the foregoing, repeats of Apollo-type missions would be lacking in increased scientific and technical value. Work would be directed toward the development of additional scientific equipments, limited mobility systems and modifications to achieve slightly longer lunar staytimes (3 days) for continuation of missions to be flown with available Apollo hardware.

As you know, the only manned earth orbital operations covered in our fiscal year 1970 budget are the Saturn I workshop and Apollo Telescope missions. No provision is made for initiating next developments other than a very limited amount for further studies. Efforts should be started in the definition and

advanced systems development for a future manned space station. In fiscal year 1970, this activity could include studies covering system and experiment definition, low-cost space shuttle logistics support systems, and mission and operation studies to develop sound options for future decisions. There could also be included long leadtime advanced developments in critical space station subsystems. These advanced developments will be required for all future manned space flight operations, civilian or military, and would not commit the Nation to specific programs, hardware, or schedules.

In support of the foregoing, a third area in manned space flight is the production of large space boosters. The production of Saturn V launch vehicle, the Nation's largest space booster, will stop with the delivery of SA-515 in 1970. We are already experiencing the loss of uniquely skilled workers at contractor, subcontractor, and vendor locations across the country. By additional funding of this activity, we could halt further erosion of this capability, reestablish sources of subcontractors and vendors, and purchase critical long leadtime hardware items. These actions would preserve the option to continue Saturn V production with deliveries commencing in early 1973.

In the earth resources satellite program, the introduction of a small limited objectives satellite to the program would permit the early space testing of different sensors in time to contribute to decisions on instrumentation for the second earth resources satellite.

With additional support in the sustaining university program, we could begin the reinvigoration of this program and respond to the increasing demands of the universities for aerospace research through multidisciplinary research and training grants.

I believe this year I would raise the program for you where previously I have been cutting it. I feel where you are decreasing your manned space flight program under Apollo \$340 million, and going up on your Apollo Application so-called, this is the time to do it.

The CHAIRMAN. Mr. Daddario.

Mr. DADDARIO. Your strategy appears to be to get support from the Congress in the amount of \$3.761 billion and have added to it from the administration those funds withheld in last year's fiscal 1969 budget in the amount of \$117 million.

Dr. PAINE. Yes, sir.

Mr. DADDARIO. In the course of this, you spell out a program which is more of a holding operation, maintaining as much as you can of what we are presently doing without too many innovations for the future. Would that be correct?

Dr. PAINE. Yes.

Mr. DADDARIO. In the process of that, you also talk about the necessity of coordinated activities. I assume that in that you mean coordination within our own country rather than coordinated programs with the U.S.S.R. as an example?

Dr. PAINE. That is correct.

Mr. DADDARIO. And following that further, on page 18 of your statement, you say that one of the objectives here should be that we should provide the technology for developing the full potential of the United States, civil and military aeronautics. Could you go into that a bit? Are we at the present time beginning to develop a stronger military activity in space than we ought to at this time, taking into consideration the research and development necessary before we are able to do many of those things which you all here portray we must do in the future, and is this a coordinating activity or are we approaching

the time when we are narrowing down our own civil, peaceful program in space and deferring as it appears to be to the military to take a greater part in the development of these activities?

Dr. PAINE. We are not deferring to the military here, but we do see an increasing need for working not only with the military but, for example, with the Department of Transportation, on matters such as the supersonic transport. The new supercritical wing development which I mentioned has great implications for subsonic commercial jets and could really bring a whole new generation into being of substantially lower cost and increased capability. NASA has the leading edge in the technological sense in this field, and of course will develop technology which has applications in both military and nonmilitary fields, and it is very important we keep coordination with both the Departments of Defense, Transportation, and other agencies, and as we proceed in this, so that this technology flows rapidly, smoothly, and effectively into appropriate use.

Mr. DADDARIO. That has been one of the hallmarks of the program up to this point, where NASA developed the experimental capabilities and made it available to all other agencies, and properly so. Yet the testimony here refers quite specifically to a greater activity of the Air Force, the work they have been doing in solid areas, their improvement design. Dr. Mueller has referred to the cutting down of our manpower in this particular area, and I would like to ask him, as the manpower emphasis in the peaceful area becomes lower and lower, what is the corresponding amount of activity in the military, specifically in the manned orbital laboratory, how big in dollars and how many people are being applied for, and as we see our peaceful program go down hill, and how steep an incline is the manpower level increase in the military?

Dr. MUELLER. I don't have the details in dollars. However, that program is in the earlier stages of its development and I believe that its requirements for funding and number of people employed will in fact continue to grow over the next year or two. Where we will have completed the development period in Apollo, they are tending to build up, so in a very real sense they are going up while we are going down.

Mr. DADDARIO. Then without getting into numbers and dollars or people, the fact is everyone here admonished us, and pointed a finger at the need of Congress to support the space program in the coming year. Spell out what more needs to be done. We see manpower decreases, and at the same time we see increases in the expenditures and manpower commitments without being able to specifically label those within the military, and that would be a correct assumption for us to make, would it not?

The CHAIRMAN. Time is running out. Can he put that in the record for you?

Mr. DADDARIO. That would take a yes or no answer.

Mr. SHAPLEY. May I comment? We can furnish for the record a summary of combined and total NASA and Department of Defense space programs. I might say the net combined effect, NASA plus DOD is still a decrease.

(Information requested is as follows:)

FUNDING SUMMARY OF NASA AND DOD SPACE PROGRAMS FOR THE PERIOD FISCAL YEAR 1961-70

[In millions of dollars]

Fiscal year	NASA		DOD		Total	
	Amount ¹	Change from previous year	Amount	Change from previous year	Amount	Change from previous year
1961.....	926.0	+464.5	813.9	+253.0	1,739.9	+717.5
1962.....	1,796.8	+870.8	1,298.2	+484.3	3,095.0	+1,355.1
1963.....	3,626.0	+1,829.2	1,549.9	+251.7	5,175.9	+2,080.9
1964.....	5,046.3	+1,420.3	1,599.3	+49.4	6,645.6	+1,469.7
1965.....	5,167.6	+121.3	1,573.9	-25.4	6,741.5	+95.9
1966.....	5,094.5	-73.1	1,688.8	+114.9	6,783.3	+41.8
1967.....	4,862.2	-232.3	1,663.6	-25.2	6,525.8	-257.5
1968.....	4,452.5	-409.7	1,921.8	+258.2	6,374.3	-151.5
1969.....	3,844.8	-607.7	2,082.5	+160.7	5,927.3	-447.0
1970 estimate.....	3,599.0	-245.8	2,218.7	+136.2	5,817.7	-109.6
10-year total.....	38,415.7		16,410.6		54,826.3	

¹ Aircraft technology amounts for NASA are excluded.

Source: BOB historical summary tables provided at their press briefing on 1970 budget.

Mr. DADDARIO. It is a decrease, but it is a decrease in the net, but a decrease in the peaceful part of the program, and increase in the incline of the military?

Mr. SHAPLEY. That is correct.

The CHAIRMAN. Mr. Mosher.

Mr. MOSHER. Mr. Chairman. I notice on page 17 of Dr. Paine's testimony that he and Dr. DuBridge and Mr. Laird are acting as a task force to prepare recommendations for proposals to the Nixon administration for changes in the Johnson budget, and each is to make some separate proposals, then get together on your recommendations, and you are meeting for the first time this week. Is it a fair question to ask you what limitations are put upon you in these proposals, are you going to have to stay within the Johnson budget, are you instructed to cut the Johnson budget, or are you given some leeway to increase it?

Dr. PAINE. Mr. Nixon asked the task force for recommendations and he left it to us to come up with the recommendations which we feel will be in the interest of the Nation without a prior judgment.

Mr. MOSHER. So you are on your own, to give your very honest, objective opinions as to what the Nation needs without any immediate limitations?

Dr. PAINE. Yes.

Mr. MOSHER. And I wouldn't ask for a guess on whether this would be more or less.

Dr. PAINE. Thank you.

Mr. MOSHER. There came to my desk yesterday a recommendation from the Council of State Chambers of Commerce, and I suppose this same recommendation came to the desk of every Member of the Congress, proposing cuts in the Johnson budget, and it proposes that all of the suggested new programs in the Johnson budget for the space program be eliminated forthwith. Now, in other words, it proposes a reduction of about \$120 million, and I would like to say that I think this would be a very short-sighted proposal. It proposes that everything new outside the manned program should be cut out completely.

But I suggest that the unmanned programs have already been minimized too much, that there has been a distortion in favor of the manned

programs. I think that those very objectives in which the Chamber of Commerce of the United States ought to be vitally interested, and in the Nation's interest would be best met by new emphasis on such programs as the earth resources satellites, and also aeronautical research, particularly the matter of aeronautical sound. The investment in those programs would bring the biggest dividends; so I repeat, theirs is a shortsighted recommendation. Would you agree with me in that?

Dr. PAINE. Yes, sir. As I mentioned in my testimony, we have enormous potential in these programs for the second decade of space that will repay many times the investments. These are investments for the future and we should be making them.

The CHAIRMAN. Mr. Hechler.

Mr. HECHLER. I would like to congratulate Dr. Paine and Mr. Lundin for some of the remarks they made on aeronautics. Following Mr. Mosher's observation, I would like to say I think the amount of increase provided for aeronautics, \$14 million, is pitifully small in terms of the challenging needs in aeronautics for the future, if indeed you are going to strengthen the base of aeronautics advance research, I think it is going to need more emphasis in the present. This committee, as you know, has tried year after year after year to encourage NASA to put more emphasis on aeronautics. I certainly think the level of effort in aeronautics doesn't begin to approach the related level that the NACA had in relation to our Nation's program back in the years before NASA. Again I would repeat, I believe the emphasis you are placing on aeronautics is pitifully small in comparison to the needs.

The CHAIRMAN. Are you through?

Mr. HECHLER. Unless any of the witnesses care to react to this observation.

Mr. LUNDIN. As I mentioned, Mr. Hechler, we are alive to the needs. Certainly reaching a balance among our many requirements is a very difficult task. We interface quite closely in our aeronautics program with other agencies of the Government. I look forward to seeing our program continue to grow in the future, but in order to do so effectively we need to make sure that our programs and work are in concert with the plans and activities of the other using agencies of the Government.

Mr. HECHLER. You are being constrained, in other words?

Mr. LUNDIN. No, sir. In developing these plans, it takes time and care to do it properly. We do not desire to act unilaterally.

The CHAIRMAN. I would like to say to my colleague that I don't think it is quite fair to make the charge Mr. Hechler did, that this group has done nothing in this field. Let me call attention to the fact that NACA had nothing to do with aeronautics.

Mr. Pelly?

Mr. PELLY. I am not going to ask any questions, but I do feel, and I feel I would fail to do properly by the three witnesses if I didn't say they set forth clearly and precisely the valuations of their programs today, and their thoughts for the future. It is good to welcome Mr. Lundin, and I second what Mr. Hechler said with regard for need for more research. I think our hearings last year brought out the fact that had we spent more money 10 or 15 years ago for research we would have saved a great deal of money in the long run and would not be today faced with many of the problems we are. I agree with Mr. Hechler and I hope we can maybe encourage NASA to step up the

areonautical research, in view of the great needs of our country today in that end.

The CHAIRMAN. Mr. Fuqua.

Mr. FUQUA. Thank you. In further relating to a question by Mr. Mosher, I was very much disturbed a few weeks ago to read there was effort on the part of the administration to reduce costs, or find that reductions could be made in the NASA budget. I am very pleased this committee has been formed to give a realistic appraisal of the needs in light of the demands of the country, both national defense and also for scientific work that you and the Secretary of Defense and the National Science Adviser may take, and I want to say I am very pleased, and I hope this is a realistic appraisal that is made, and there will not be constraints put on you to come up with some preconceived recommendations that you maybe feel is not in the best interest.

The CHAIRMAN. Mr. Rumsfeld.

Mr. RUMSFELD. I have a question for Dr. Paine. On page 17 regarding this group created by President Nixon. As I read your testimony it has nothing to do with the present fiscal year, really. At least you specify post-Apollo. I can't see that the responses to the questions proposed to you conform to the testimony.

Dr. PAINE. It is aimed at the 1971 time phase because of the reporting date of next September to the President. But at the same time starting immediately with our meetings this week we will be discussing the question of whether any adjustments should be made in the immediate time phase also.

Mr. RUMSFELD. What is your timetable on this? Have you discussed it with either of your two associates?

Dr. PAINE. The timetable is a report to the President in September, with interim reports in the intervening time.

Mr. RUMSFELD. But as far as post-Apollo aspects of the report, you are shooting for September.

Dr. PAINE. Correct. The deadline for reporting to the President is September.

Mr. RUMSFELD. I note here that the President has requested that the members of the task group consult as appropriate with State agencies, other executive agencies, and the Congress. Do you have any thoughts as to what form your consultation with the Congress might take?

Dr. PAINE. I have not thought a great deal about it, to be honest. We are just having our first meeting this week.

Mr. RUMSFELD. At the last paragraph of page 17, and the following material on page 18, you set forth NASA's major program goals for the next 10 years, at least some things you feel should be included. Is it correct to assume this is your recommendation to this task group that has been set up by the President?

Dr. PAINE. This is certainly hopefully a one-page accurate and lucid description of my views at the present time. These of course will have to be discussed in the task group, and then there is the basic question of national priorities that the President will have to address himself to in putting his space programs. This is certainly my view at the present time of what should be done by the United States in space.

Mr. RUMSFELD. I will look forward with great eagerness to seeing some amplification of your remarks on page 18.

The CHAIRMAN. Mr. Cabell.

Mr. CABELL. I merely want to comment and commend you for working into the testimony some concrete results of the technology, and even hardware that has been developed as applies to the man in the street or applied to industry. I think that that has been one of the places, one of the areas we have fallen down in publicizing, and the more we can show John Doe where he is benefiting directly, either in his work, from medical diagnosis, from treatment, then the more public support of NASA we will get, and I hope that that program of disseminating that information can be accelerated, and I commend you for it.

The CHAIRMAN. Mr. Winn.

Mr. WINN. Along that same line, Dr. Paine, on page 11—and I want to commend you for your statement, paragraph No. 1 there on the earth resources technology satellite program. I too would like to see the people in the street benefit, and I am aware, and members of the committee are, we have said we have medical benefits, and some agricultural benefits, and various benefits that we have been talking about, but I would hope the new administration and all those connected with it should try a little harder to see if we can make it a reality. I question the statement in here that possibly the budget has been holding this back. Twice you refer to if the budget is approved by Congress. Here you say hitherto we have been limited by budget constraints to experimentation on the ground and from aircraft, sensor development and studies of satellite systems. And I don't think really that the members of the committee feel this way, and I would question that statement, but would hope to give you time to prove it.

The CHAIRMAN. Mr. Biaggi.

Mr. BIAGGI. No questions.

The CHAIRMAN. Mr. Price.

Mr. PRICE. Dr. Mueller, I would like to pursue a little bit what we were talking about the other day at the Cape. Do you gentlemen feel that we have projected into the future and outlined a program that will have an evenflow and continuation over the years, a steady progress, to avoid these dropoffs as was demonstrated in the graph the other day. In other words it seems to me we come up here with the Apollo program, it will be over, we build skills for these people over 10- to 20-year periods, and now we lose these people in the interim period between now and say 1972, and then it gets another peak and then goes down again. Of course, this is all subject, I know, to the amount of money that Congress appropriates, and it is hard to determine this, but do you feel that in the next 10 to 15 years that we will be able to avoid some of this?

Dr. MUELLER. It is quite clear we can plan to avoid at least major fluctuations in the total work force in this space area. It is also quite clear that this budget does not provide for the implementation of any plan that would avoid fluctuations. It would force us to reduce the number of people in the manned space flight program essentially to zero, by the end of 1972.

Dr. PAINE. This is why we feel it is urgent for us to develop a 10 year space program.

Mr. PRICE. Don't you think we ought to be projecting further?

Dr. PAINE. If we can get 10 years now I will be very happy.

Mr. PRICE. It seems to me like Apollo, we planned for 10 years, now where do we go?

Dr. PAINE. Our internal plan of process is a 15-year period.

Mr. PRICE. But it seems we should have a 10, 20, 30, 40, 50 year, so this thing can move along.

The CHAIRMAN. Mr. Symington.

Mr. SYMINGTON. I think the testimony does reflect an awareness of the public concern for expenditures which don't seem to relate directly to them, and I think that the mention here of the number of the technological values that are evolving from this is going to be helpful. There was a failure to mention one aspect of commerce transportation assistance which I think will help sell the program to the public, and that is safety. It occurs to me that the chance of accidents, difficulty of planning airports, things of that nature, are on the increase, and I wonder if there is any thought being given now by you to the prospect of making commercial air transportation safer through the design of the planes, or other vehicles, or any other way.

Mr. LUNDIN. As I mention very briefly in my summary statement, safety as well as noise are two of the technological areas we are attempting to emphasize. Among these are such things as landing aids, fog dispersal, tire runway traction research, and similar activities. We do desire, and do, in this budget, give emphasis to matters of aircraft safety.

The CHAIRMAN. Mr. Weicker.

Mr. WEICKER. Dr. Mueller, I find it a little hard to ascertain in my mind exactly what it is you need when you present a budget with what seems to me less than unbounded enthusiasm. Where are the restrictions in the preparation of this budget, is this your budget that you are presenting to this committee, or have restraints been put on it prior to presentation before this committee.

Dr. PAINE. I will be glad to respond. The budget system is such that we make proposals to the President, these have to go through the review of many other resources, and very clearly President Johnson did take a very strong view on the necessity for economy in the process of looking at our programs. He felt that reaching the end of his administration he should properly defer some basic decisions, and particularly with respect to the future of manned space flight, to the Nixon administration. So we are presenting a budget here which does not contain new programs in the area of manned space flight, and this is one of the reasons President Nixon asked for this very early-on review.

Mr. WEICKER. Then the last question, have you made any estimate—in the course of touring the facilities of the Cape last week I came across many of your facilities which have been shut down—have you come forth with any estimates of what it costs to reactivate these?

Dr. MUELLER. Yes. For example, the 34-37 launch complex for the Saturn IB launch vehicles has been essentially mothballed at this point in time, with a view to reopening it for five launches in 1971 and 1972. The cost of this 3-year period is estimated to be approximately \$300 million, including carrying out the launching.

Mr. KOCH. Dr. Paine, critics of the NASA program often take the position that the manned space flights that have been held, which cost four or five times more than an unmanned space flight of a comparable kind, do nothing other than provide a psychological uplift for the country and that little, if anything, practical comes out of a manned space flight that would not otherwise be had in an unmanned space flight. Could you comment?

Dr. PAINE. I would be happy to do that, but Dr. Mueller would be breathing down my neck. I would defer to him.

Dr. MUELLER. I think it is quite clear that men are capable of doing things that are quite different than what can be done by machines. The argument for machines versus men generally hinges on the argument of cost rather than anything else. In the case of lunar exploration, I think all of us agree, and all of our critics agree, we are better able to carry out the exploration of such an unknown new territory with men, and our own cost analysis indicates that it is in fact a cost-effective way of doing the job. Now, when it comes to earth orbital operations, I think in each case you have to acknowledge the relative cost of carrying out a particular activity you have in mind. In the case of developing new experimental apparatus it almost always turns out to be equally effective to use men. This is because of the ability of a man to change equipment, to adapt to the situation. An example is the solar observatory, the Apollo telescope, which is an integral part of Apollo Applications. This is a clear case where men are required in order to do the experiments.

So there are things where machines are better. We need machines, but we still have to have a man to guide them.

Mr. KOCH. Would you at some time or other put in the record what it is that manned space flights have produced that a comparable unmanned space flight would not have been able to do, and cover those for the future interplanetary programs.

Dr. MUELLER. I would be happy to.

(The information requested for the record follows:)

The manned space flights we have conducted to date and the next several flights planned have been aimed primarily at learning how men can live and operate in space and at developing and demonstrating equipment that can give them this capability. By national decision over 8 years ago, the United States took the development of the capability for manned space flight as an objective. The specific goal of the Apollo program to land men on the moon and bring them back safely to earth was adopted to serve as the focus for the broad and complex effort required to develop a national manned flight capability.

The question on the scientific returns of the manned space flight program must therefore, be considered in the light that the initial objective of the program has necessarily been to develop and understand the capabilities of manned space flight itself. Missions with the primary purposes of gathering scientific data or conducting other useful operations are still some time in the future. The same evolution has been necessary in unmanned space flight, where the early flights and, even now the first flights of some advanced satellites, have a primary mission to develop and test the equipment required for the operation of the spacecraft itself. In both the manned and unmanned areas, however, the missions directed primarily at the development of space capabilities have also been used—to the maximum extent feasible in each case—to gather as much useful scientific data as possible.

For the reasons indicated, much of the scientific data gathered in our manned flights to date has related to the functioning of man himself in space, e.g., biomedical data on the effects of weightlessness, and to the engineering aspects of life support and other systems on which success of manned space flight depends. In addition, however, valuable scientific data has been obtained in a variety of other fields. The earth photographs obtained in the Gemini and Apollo programs are being analyzed by scientists in a wide range of disciplines—geology, hydrology, agriculture, and others—who are finding them an important source of data. The lunar data brought back by the Apollo 8 astronauts is likewise of unique value to the scientific study of the moon. The scientific return from actual landings and subsequent manned exploration of the moon will, of course, provide many scientific data which cannot be obtained in any other way.

As we look ahead, first to the actual landing of men on the moon, then to subsequent manned exploration of the moon and to the manned operations in earth orbit in the approved Apollo applications program, and farther in the future to space stations in earth orbit, we see a period in which we will be using

for scientific and applications purposes the capabilities we have developed. The scientific exploration of the moon with the Apollo system and precise observations of the sun with the Apollo telescope in the Apollo applications program will be the first major specific examples.

The approach we are taking in our planning is to focus our manned program on objectives where the presence of man in space is necessary or offers substantial advantages and on the objective of continuing the development of the Nation's manned space flight capabilities for the long-term future. Each manned mission flown for these reasons will also be taken advantage of to conduct as many additional scientific experiments as possible even though similar data might be gathered on separate flights of unmanned satellites.

A summary of what has been accomplished on each manned flight to date follows:

MERCURY PROGRAM

Six missions in 2 years (May 1961 to May 1963).

One man each flight: two suborbital, four orbital.

All missions completed with safe recovery of the astronauts.

Total man-hours in space: 53.

Flight durations: MR-3 and MR-4, 15 minutes each; MA-6 and MA-7, 5 hours (three orbits) each; MA-8, 9 hours (six orbits); MA-9, 34 hours (22 orbits).

Program demonstrated that—

Man can survive and perform useful functions in weightless space flights lasting up to $1\frac{1}{2}$ day. High accelerations of launch and re-entry do not impair his functions.

A trained astronaut can control the orientation of his spacecraft. Through such control, he can affect the re-entry flight path and thus the landing point. He can steer by observation of prominent landmarks, such as a brightly lit city at night.

Spacecraft can be designed with sufficient reliability for safe operation by men. Launch vehicles intended for military missiles can be adapted for transporting men into space. A worldwide communications network can be operated to keep in touch with and control manned spacecraft on a real-time basis. Naval forces, supported by aircraft and helicopters, can be employed for recovery at sea.

Mission	Dates	Crew	Major Features
MR-3.....	May 5, 1961.....	Alan Shepard.....	Suborbital, 15-minute duration, 1st U.S. flight.
MR-4.....	July 21, 1961.....	Virgil Grissom.....	Same as MR-3, except spacecraft lost.
MA-6.....	Feb. 20, 1962.....	John Glenn.....	3 orbits (4 hours, 55 minutes) 1st U.S. manned orbital.
MA-7.....	May 24, 1962.....	Scott Carpenter.....	Same as MA-6.
MA-8.....	Oct. 3, 1962.....	Walter Schirra.....	6 orbits (9 hours, 13 minutes).
MA-9.....	May 15-16, 1963.....	Gordon Cooper.....	22 orbits (34 hours, 22 minutes) oriented manually for reentry.

GEMINI PROGRAM

Ten missions in 20 months (March 1965 to November 1966).

Two men each flight.

All missions completed with safe recovery of the astronauts.

Total man-hours in space: 1,940.

Long-duration flights: Gemini IV—4 days; Gemini V—8 days; Gemini VII—14 days. These flights proved man can live and work effectively in space. Up to 14 days there are no detrimental effects of space flight.

Guidance and Rendezvous: Gemini VII, Gemini VIII, Gemini IXA, Gemini X, Gemini XI, Gemini XII. Gemini X dual rendezvous with Agena target and the Agena from Gemini VIII mission. Gemini XI rendezvous on first orbit.

Docking: Gemini VII, Gemini X, Gemini XI, Gemini XII.

Post-docking maneuvers: Gemini X, to altitude of 475 statute miles; Gemini XI, to altitude of 850 statute miles.

Re-entry flight control: Gemini VII, VIII, IX, and X controlled manually, touched down within distances of 0.38 to 6.4 miles of desired point: Gemini XI and XII, controlled automatically, touched down within 2.6 and 2.65 miles of desired point. On five flights, the descending spacecraft was within sight of the recovery forces.

Flight and ground crew proficiency: Turnaround permitted launch of Gemini VI from same pad within 11 days of launch of Gemini VII.

Extra-vehicular activity: 6 hours, 1 minute outside spacecraft, attached to umbilical; 6 hours, 24 minutes "standup" partly inside and partly outside spacecraft, on five flight missions—Gemini IV, IX, X, XI, and XII; micrometeoroid collection package attached Agena 8 retrieved on Gemini X and returned to earth for analysis; results showed that extravehicular operation in space is feasible and useful for productive tasks if adequate attention is given to body restraints, task sequence, workload control, realistic simulations, and proper training.

Space photography: More than 2,400 color photographs of earth features demonstrated the feasibility of employing sensing techniques for assessment of earth resources—weather, air pollution, oceans, hydrology, agriculture, geography, minerals, and the interrelationships among various elements. These pictures played a major role in stimulating the current interest in the potential of this program.

Other science experiments: Seventeen experiments to observe earth phenomena, to make astronomical observations, to detect space dust and nuclear particles, to investigate interaction of the spacecraft and the space environment, to observe the reaction of biological specimens to the space environment, and to test human visual acuity in space.

Technological experiments: Twenty-seven experiments to investigate the operation of proposed devices for improved communications, controls, navigation, observation, and use of tools in the space environment.

Medical experiments: Eight experiments to obtain information on the ability of man to live and work in the space environment.

Mission	Dates	Crew	Major features
Gemini III.....	Mar. 23, 1965.....	Virgil Grisson, John Young.....	Verified launch systems performance, spacecraft operation, orbital maneuvering system, on-board control of re-entry flight paths, communications and recovery, 3 orbits (4 hrs., 53 min.).
Gemini IV.....	June 3-7, 1965.....	James McDivitt, Edward White.....	4 days duration (97 hrs., 56 min.). White performed 1st U.S. extravehicular activity, and 1st use of personal propulsion.
Gemini V.....	Aug. 21-29, 1965.....	Gordon Cooper, Charles Conrad.....	8 days duration (190 hrs., 56 min.). Operated fuel cell and rendezvous radar. Performed rendezvous maneuvers.
Gemini VI.....	Oct. 25, 1965.....	Not launched.....	Launch failure of Agena target system.
Gemini VII.....	Dec. 4-18, 1965.....	Frank Borman, James Lovell.....	14 days (330 hrs., 35 min.). Served as target for rendezvous. Landed within 7 miles of planned point.
Gemini VIA.....	Dec. 15-16, 1965.....	Walter Schirra, Thomas Stafford.....	25 hrs., 51 min. Achieved rendezvous within 6 feet of Gemini VII, kept station 5½ hrs.
Gemini VIII.....	Mar. 16, 1966.....	Neil Armstrong, David Scott.....	Dual launch of Gemini and Agena target. Achieved rendezvous and docking. Electrical short circuit caused spacecraft to spin out of control. Crew shifted control modes and terminated mission after 10 hrs., 41 min., of planned 3 days. Recovery in Pacific instead of Atlantic.
Gemini IX.....	May 17, 1966.....	Not launched.....	Atlas-Agena target launch failure.
Gemini IXA.....	June 3-6, 1966.....	Thomas Stafford, Eugene Cernan.....	3 days (72 hrs., 21 min.). Dual launch of Gemini and backup target vehicle. Rendezvous achieved but vehicles could not dock because shroud failed to clear docking adapter. Cernan performed 2 hrs., 2 min., extravehicular activity. Landed 0.38 miles from desired point.
Gemini X.....	July 18-21, 1966.....	John Young, Michael Collins.....	3 days (70 hrs., 47 min.). Dual launch and dual rendezvous, docking with Agena 10, rendezvous with Agena 8. Collins extravehicular activity to retrieve micrometeoroid experiment, total EVA 72 min. Maneuvered to altitude 475 stat. mi.
Gemini XI.....	Sept. 12-15, 1966.....	Charles Conrad, Richard Gordon.....	3 days (71 hrs., 17 min.) 1st-orbit rendezvous. Docking with Agena and maneuver to altitude of 850 stat. mi. Extravehicular activity by Gordon 2 hrs., 55 min. Agena separated and placed on 100 ft. tether for 2 hrs. Automatic re-entry.
Gemini XII.....	Nov. 11-15, 1966.....	James Lovell, Edwin Aldrin.....	4 days (94 hrs., 34 min.). Rendezvous, docking and maneuver into position to photograph solar eclipse. Extravehicular activity by Aldrin 5 hrs., 37 min. Agena placed on 100 ft. tether, which was aligned vertically and held taut by gravity differential. Automatic reentry.

APOLLO PROGRAM

The following equipment in operational status as the result of successful testing in manned flight: Command, service and lunar modules of Apollo spacecraft; Apollo spacesuit; Saturn IB and Saturn V launch vehicles; Launch Complex 39 at Kennedy Space Center, including Vehicle Assembly Building, Launch pad, mobile service structure, crawler-transporter and launch control center; Mission Control Center at Houston; worldwide network of communications, tracking and data acquisition stations; recovery forces including ships, aircraft, helicopters, and swimmers.

All but two flight phases completed in program leading to manned lunar landing and safe return of the astronauts.

Three manned missions in 5 months (October 1968 to March 1969).

Three men each flight.

All flight missions completed with safe recovery of the astronauts.

Flight to 240,000-mile lunar distance, 20 hours in lunar orbit, return to earth from lunar orbit, communications including live TV from lunar orbit—Apollo 8.

Total man-hours in space: 1,944.

Long-duration flights: Apollo 7—10.8 days; Apollo 9—10 days.

Separation of lunar module from command and service modules, transposition and docking; rendezvous maneuvers: Apollo 9.

Extravehicular activity: 1½ man-hours, Apollo 9.

Mission	Dates	Crew	Major features
Apollo 7.....	Oct. 11-22, 1968.....	Walter Schirra, Donn Eisele, Walter Cunningham.	10.8 days (260 hours, 8 minutes). First manned flight of spacecraft command and service modules; first manned launch of Saturn. 8 firings of service module propulsion. Rendezvous with Saturn stage.
Apollo 8.....	Dec. 12-27, 1968.....	Frank Borman, James Lovell, William Anders.	6 days (147 hours, 1 minute). First manned launch of Saturn V, first flight beyond earth orbit, flight to a distance 240,000 miles from earth, maximum speed 24,000 miles per hour, first flight to gravitational zone of another celestial body. Communications and live TV from lunar distance. Navigation and midcourse corrections. First manned flight in lunar orbit (10 revolutions, 20 hours, 11 minutes). Landing 3 miles from recovery ship.
Apollo 9.....	Mar. 3-13, 1969.....	James McDivitt, David Scott, Russell Schweickart.	10 days (241 hours). First manned flight of lunar module (28 hours, including 6 hours, 24 minutes, undocked.) First flight of a manned spacecraft without earth-landing capability. Rendezvous and docking. Extravehicular activity by Scott and Schweickart 42 minutes each. First EVA with independent oxygen source. Navigation and control exercises. Earth photography, including experiments with multispectral sensing.

The CHAIRMAN. I think this has been put in the record many times, but we can do it again. If I am not mistaken, wasn't it the Glenn flight, that if he hadn't been in the capsule it would have been a complete loss?

Dr. MUELLER. Yes.

The CHAIRMAN. And on this present flight, where things got out of hand, that the men in the capsule could correct. Mr. Frey.

Mr. FREY. I would like to just briefly join with my colleague from Florida in his comments. I am concerned with the drop, not just recently, but over the last 4 and 5 years. It has been said, and I have heard it said, that the space program has put more technology, more know-how, and created more jobs for the free enterprise system than any other program this country has, except our basis educational system. Would you care to comment?

Dr. PAINE. I think the contribution of the space program is analogous in many ways to the kinds of contributions made in the technology programs in World War II, on which so much of today's prosperity depends, such as the jet aircraft industry, computers, synthetics, many things that in a short period of time have cast a great wealth in the Nation. A lot of these returns will be returns that come in the future, and we can't even predict what all of them would be. Certainly in the area of weather, communications, where already the Communication Satellite Corp. sells stock in Wall Street and makes a profit now. And what we see in the future will bypass these investments many times over.

Mr. FREY. Is there any way you can estimate, or take a guess at the tremendous economic loss to this Nation if we didn't continue this program at a proper level?

Dr. PAINE. I think we would have a great economic loss, a great spiritual loss, a great loss in power and prestige. I think it is unthinkable we would not continue.

Mr. FREY. At the proper funding.

Dr. PAINE. Yes.

Mr. FREY. And one thing that has concerned me is the breakup of these teams that have been put together. Do you have any estimates costwise both in time and dollars of putting these teams back together? I don't think people realize there is a tremendous economic factor involved.

Dr. PAINE. These have been costly, but I think on the other side it is fair to say many of the people involved have gone to other areas where they take the space technology with them. I think it is the loss of the ability to work together, that is the loss, and it is difficult to put in dollars and cents. In the positive sense it again puts a premium on coming up with a sound plan for the future space program that will minimize these up and down cycles.

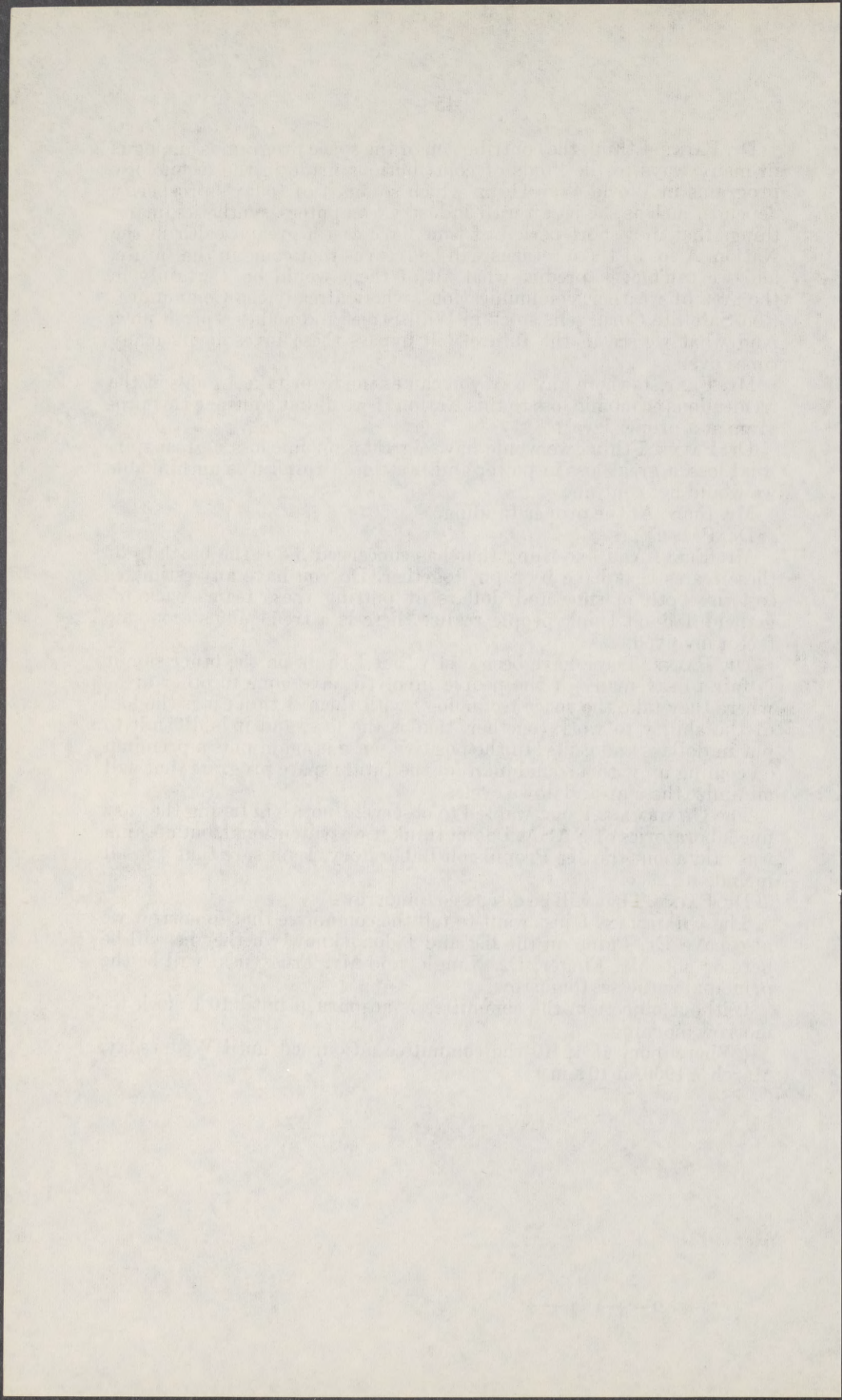
The CHAIRMAN. I just wanted to observe, I notice in listing the very fine laboratories of NASA, I don't think it was intentional, but nothing was said about the Jet Propulsion Laboratory. I am sure that you all include it.

Dr. PAINE. That will be discussed tomorrow.

The CHAIRMAN. I just want to tell the committee that tomorrow we also have Dr. Paine on the list and I don't know whether he will be here or not. Mr. Finger, Dr. Naugle, and Mr. Truszynski will be the principal witnesses tomorrow.

Without objection, the committee is adjourned until 10 o'clock tomorrow morning.

(Whereupon, at 12:10 the committee adjourned until Wednesday, March 5, 1969, at 10 a.m.)



1970 NASA AUTHORIZATION

WEDNESDAY, MARCH 5, 1969

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

The committee met at 10 a.m., in room 2318, Rayburn House Office Building, Hon. Olin E. Teague, ranking majority member, presiding.

Mr. TEAGUE. Please come to order.

Chuck Mathews, will you give us a status report on what is going on upstairs.

Mr. MATHEWS. Yes. I will talk about yesterday first. Yesterday was the day of the series of service propulsion system burns. There were a series of them because the LM coupled with the CSM was being tested in this manner for the first time. The reason this is important is that this coupling is rather flexible, that is the narrowest part of the two vehicles where they are docked, and you have to be very careful about the stability of that particular system, and the digital auto-pilot is carefully designed for that flexibility.

So these burns were actually built up in a series of longer and longer durations, and as it worked out they were highly successful, being exceedingly close to phenomenal. For example, the longest burn was nominally 280 seconds; it did burn a little longer, 292 seconds. The velocity that was obtained was close to nominal, and the orbit obtained was 262 by 109 nautical miles, as compared to 208 by 111 that was asked for, so that did work very well.

They also did during these burns stock stroking tests that tried to excite oscillations, and these were stable and exactly as they were calculated.

Now, that gets to this morning, and this morning they were running about an hour and a half late as they started. Rusty Schweickart, the lunar module pilot, woke up ill this morning with an upset stomach. I don't know much more about it than that, I don't know the reason why, but this did delay the activities to some degree. Right now, Rusty is feeling OK—A—OK, I guess.

We are going to have to watch that pretty carefully today, because Rusty is the crewman that will accomplish the EVA tomorrow.

In spite of that, today they are checking out the LM in various ways, and have deployed the landing gear on the LM, and have gone through checks and there are no LM problems through the present time.

About noontime, really a little later than that, about 12:40, they will be burning the descent propulsion system in a long burn which will be the first burn of the LM engine. The engine is used in conjunction with the landing on the Moon.

Tomorrow, of course, the big event is the EVA, which is currently planned to again occur around noontime. They have bypassed a few of the LM checkouts in order to try the descent propulsion system, and will pick up the other part of the checkout later on this afternoon.

That is all I have.

Mr. TEAGUE. Are there any questions of Mr. Mathews?

Mr. WYDLER. May I just ask this question? Has the performance of the LM, so far, been up to expectations?

Mr. MATHEWS. Yes, sir, it has been. As they have powered the LM up and checked out the various systems, there are no anomalies in evidence.

Mr. TEAGUE. Thank you.

I would remind the members that yesterday the chairman stated that the three witnesses this morning, Mr. Finger, Mr. Naugle, and Mr. Truszynski, would be allowed to complete their testimony before being questioned.

We will run to about a quarter to 12, and then we will have a 5-minute film on Apollo 9 flight.

Mr. Finger, are you ready?

(A biographical sketch of Harold B. Finger, Associate Administrator for Organization and Management, is as follows:)

HAROLD B. FINGER

Mr. Finger was appointed to this position on March 15, 1967, reporting directly to the NASA Administrator. He is responsible for the evaluation and strengthening of agencywide management policies and practices involved in the conduct of NASA programs and activities. Reporting to him are Assistant Administrators for Administration, University Affairs, Industry Affairs, Technology Utilization, and Special Contracts Negotiation and Review. His responsibilities include agencywide budget and financial management, the manpower and personnel management program, construction and facilities management, procurement and contracting, organization and management evaluation, general administration, and the NASA programs in technology utilization and university affairs. Also reporting to him are elements responsible for audit, inspection, and headquarters administration.

Prior to his appointment, Mr. Finger served (August 1960 through March 1967) as Manager of the Space Nuclear Propulsion Office, a joint NASA/AEC organization for the development of and testing of nuclear propulsion systems, with extension offices in Cleveland, Albuquerque, and at the Nevada Test Site. During this same period, Mr. Finger also held simultaneous appointments as Director, Space Nuclear Systems Division for AEC (June 1965-March 1967) and Director, Space Power and Nuclear Systems for NASA (January 1964-March 1967). His NASA responsibility included research and development on advanced solar, chemical, and nuclear power systems, their application to space propulsion, and their development through flight testing.

Finger joined the National Advisory Committee for Aeronautics, the predecessor to NASA, in 1944 as an aeronautical research scientist at the Lewis Research Center, Cleveland, Ohio. In 1952 he was named head of the Axial Flow Compressor Section and in 1954 Associate Chief of the Compressor Research Branch with responsibility for a large part of the NACA's research in aircraft propulsion. Later he served as head of the Nuclear Radiation Shielding Group and a Nuclear Rocket Design Analysis Group.

Finger has been on the NASA Headquarters staff since it was established in October 1958. He was Chief of Nuclear Propulsion Programs (through August 1960), Assistant Director for Nuclear Applications (through November 1961) and then Director of Nuclear Systems (through January 1964).

Finger was born in New York City, February 18, 1924. He received a BS degree in mechanical engineering from the City College of New York in 1944 and was awarded an MS degree in aeronautical engineering at the Case Institute of Technology in 1950. Author of numerous technical papers, he was co-winner of the 1957 Society of Automotive Engineers' Manley Award for the best

paper on aeronautics and was the recipient of the AIAA James H. Wyld Propulsion Award in April 1968. He is a member of the American Institute of Aeronautics and Astronautics.

Mr. and Mrs. Finger (the former Arlene Karsch) and their three daughters live in Bethesda, Md.

**STATEMENT OF HAROLD B. FINGER, ASSOCIATE ADMINISTRATOR
FOR ORGANIZATION AND MANAGEMENT, NATIONAL AERONAUTICS
AND SPACE ADMINISTRATION**

Mr. FINGER. Mr. Chairman and members of the committee, I have submitted to the committee a prepared statement which runs longer than the time limits will allow, so I will just use the prepared statement as an outline and make my oral presentation shorter by skipping certain sections; but I will generally follow the order of this prepared presentation.

NASA's approach to the conduct and management of its space and aeronautics program relies on the capabilities of Government, industry, and university organizations. In implementing this approach, NASA has utilized the scientific, engineering and management competence of its inhouse laboratories to manage its complex research, development and flight missions and to work with other Government agencies, industry and universities in ways that strengthen these institutions and, thereby, increase our national well-being and strength.

The contributions of these various organizations to NASA's program and their capabilities are apparent in the rockets and space flight systems that have been built by industry, in the large number of flight experiments and space science reports prepared by university scientists, and in the results of our inhouse research and in the planning and management of even the most complex of our space missions—like Apollo—by our inhouse scientists, engineers and managers.

Because of the importance of this inhouse capability to the successful accomplishment of our programs, because it requires a large part of our total budget request, and because no one of the subcommittees reviews the overall resources required to support this inhouse capability, we believe it necessary to describe to the full committee the full Research and Program Management (RPM) budget, which is the new and more accurate and descriptive title given to the Administrative Operations budget of prior years. After discussing the RPM budget, I will then summarize briefly the work NASA is doing with universities in both its project activities and in the Sustaining University Program for which we are requesting new obligational authority of \$9 million in the budget before you. And, finally, I will briefly review some of the recent activities and plans for the Technology Utilization Program which provides for the identification and dissemination of knowledge acquired in our aeronautics and space activities that may be applicable to other parts of our national economy. We are requesting \$5 million for this part of our program.

The Research and Program Management budget request for fiscal year 1970 is \$650.9 million. Although this dollar amount is about \$2.6 million higher than our fiscal year 1969 operating budget, the fiscal year 1970 request continues the reduction in our civil service manpower that started in 1967 and continues the austere operating levels established during fiscal years 1968 and 1969.

Seventy-two percent of our fiscal year 1970 request in this Research and Program Management appropriation covers the salaries and benefits of all NASA civil service personnel and civilian and military personnel detailed to NASA by other Government agencies; it includes the salaries of the scientists, engineers, and the supporting technicians that make up 70 percent of the total NASA civil service work force.

This appropriation also covers the direct expenses of operating our laboratories. It provides funds for maintenance and operation of our facilities at our Centers. It supports the development and installation and operation of our general purpose computer capability and the logistics support and administrative support required in these Centers.

Thus, this appropriation provides funds for the Government's scientific, engineering, and management manpower within NASA to plan, review, and make major decisions on the work that is to be done at Government expense. It provides the funds to operate the NASA laboratories, which have been established as the Government's technical and management interface for contract activities to work with our contractors in anticipating problems, in applying the results of our inhouse research work for the solution of the problems and the definition of improved research, hardware, and mission concepts. We have therefore renamed this part of our budget as the Research and Program Management appropriation to reflect more accurately and fully the work it supports. This is not an administrative overhead account as many feel was implied by the Administrative Operations title used in previous years.

The fiscal year 1970 Research and Program Management budget request of \$650.9 million has been developed on the basis of continuing the economies achieved in the past several years and in recognition of the expressed intent of the Congress and the President to reduce expenditures to the minimum. These economies are readily apparent from a brief review of our fiscal years 1968 and 1969 operations.

In fiscal year 1968 we requested \$671.3 million in our budget request. The Congress authorized \$648.2 million and then appropriated \$628 million—a reduction of \$43.3 million from our request. Our operating plan was established within this total dollar level by reducing the employment we had planned by 1,704 permanent civil service positions, and reducing our costs for budget items other than personnel cost by nearly 18 percent. The only funds that were transferred to the appropriation in the original operating plan were \$12.5 million to cover costs of pay increases under the Federal Salary Act of 1967, which became effective in October 1967.

Near the end of the fiscal year 1968, 127 additional positions were established for the conversion of certain support contract functions to civil service operations at Goddard Space Flight Center. This conversion was made as a result of the opinion of the Civil Service Commission's General Counsel that operations under these contracts were proscribed by personnel statutes. In addition, the Bureau of the Budget approved the retention of 120 employees as part of our agreement with the Civil Service Commission to permit proceeding with the required reduction-in-force at Marshall Space Flight Center.

After these major adjustments, our final operating budget for fiscal

year 1968 provided a total of \$639.3 million and reduced our onboard manpower strength by 1,255.

In fiscal year 1969 our budget request was for \$648.2 million. This was developed by retaining the base of \$628 million appropriated in fiscal year 1968, increased only enough to cover the \$18.6 million required for the full year cost of the general salary increase which had been effective for only part of fiscal year 1968, and to cover the \$1.6 million cost of the support service contractor conversions at Goddard. This request was reduced by floor action to \$603.2 million.

The effects of a reduction to \$603.2 million were assessed, and it was considered that such a reduction—\$45 million—would have been so large that it would make impossible the successful and effective execution of the programs approved by Congress. At the \$603.2 million level, even after all other economies were made, it would have been necessary to reduce the planned employment in permanent civil service positions by at least 4,900 positions. That assumed that the separations would have occurred by September 1, and for every month the reduction was delayed another 700 positions would have to be eliminated.

In order to avoid such damaging effects, it was determined that the minimum acceptable operating level was \$623.3 million, so \$20.1 million were transferred to the appropriation from our Research and Development appropriation. Even at this level, a reduction of 1,661 positions was required in planned employment and a reduction of more than 10 percent was made in all costs other than the personnel costs. The operating budget level of \$623.3 million is still significantly less than the \$646 million recommended by the House Authorization Committee and the \$635 million recommended by the Senate Authorization Committee.

In addition to the reprogramming of \$20.1 million to establish a minimum operating level, two other major adjustments have been made in our Fiscal Year 1969 operating budget. The second increment of the increases in salaries resulting from the Federal Salary Act of 1967 became effective in July 1968. The estimated cost of the increase had not been included in the NASA budget request, since the entire governmentwide cost was included in the President's overall budget without distribution by agency. The cost of this increase—\$23.7 million—was provided by transferring to the Research and Program Management appropriation, funds withheld by the Bureau of the Budget from NASA's Research and Development appropriation.

The other major increase results from additional conversions to civil service operation of certain support service functions being carried out under contract at Goddard. These conversions are being made as a result of detailed studies which established that certain contracts were similar to those the Civil Service Commission had held were proscribed by personnel statutes. Therefore, 810 additional civil service positions have been planned to carry out these functions—559 in fiscal year 1969 and an additional 251 are included in fiscal year 1970 to complete the conversion.

Early in May 1968 when it became apparent from pending legislation that the fiscal year 1969 operating plan would be significantly

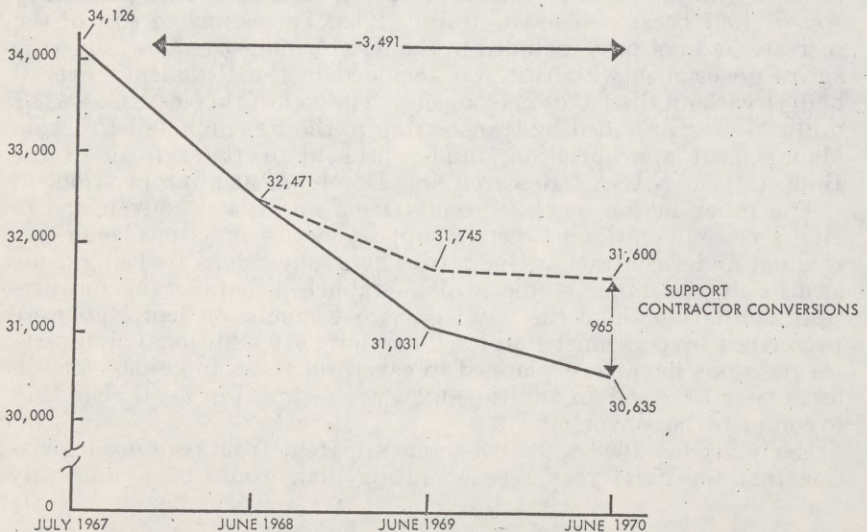
below our request, action was then taken to restrict employment prior to the end of fiscal year 1968 in order to avoid large and disruptive reductions in personnel after the beginning of fiscal year 1969. As a result of these early actions, the on-board manpower complement is being reduced by 1,285 in fiscal year 1969 and 559 new positions are being established at Goddard for support service operations.

On the chart here it is shown that from our highest civil service employment level of 34,126 in July 1967, the number of NASA's permanent employees will have decreased by 2,526 to 31,600 at the end of fiscal year 1970. During this same time period, 965 positions will have been established specifically to convert certain support service functions that have been carried out under contract with industry to civil service operations. This results in an effective decrease in manpower of 3,491, with a reduction from our planned manpower of 4,374. There has been a significant decrease in our manpower over the years, and the fiscal year 1970 budget continues that decrease.

We are planning all of these reductions in personnel by attrition—not refilling all positions that become vacant as employees leave. This is becoming increasingly difficult since the rate of separations has slowed appreciably and the separation rate is not the same in all skill and discipline groups. The overall separation rate during the current year is only about two-thirds of the rate for fiscal year 1968.

It should be noted that we are required to forfeit 30 percent of our vacancies resulting from resignation, retirement, removal or death under the directive established by the Director of the Bureau of the Budget of the Budget implementing the requirements of Section 201 of the Revenue and Expenditure Control Act of 1968. The 559 positions established this fiscal year for conversion of the contracted functions at

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
CHANGES IN END OF YEAR PERMANENT CIVIL SERVICE POSITIONS



Goddard must be accommodated within the refillable vacancies allowed under the provisions of Section 201. Therefore, before these new functions can be taken on at Goddard, we must reduce our actual employment at a rate more than twice as great as is required by the tax bill and the BOB implementing directive.

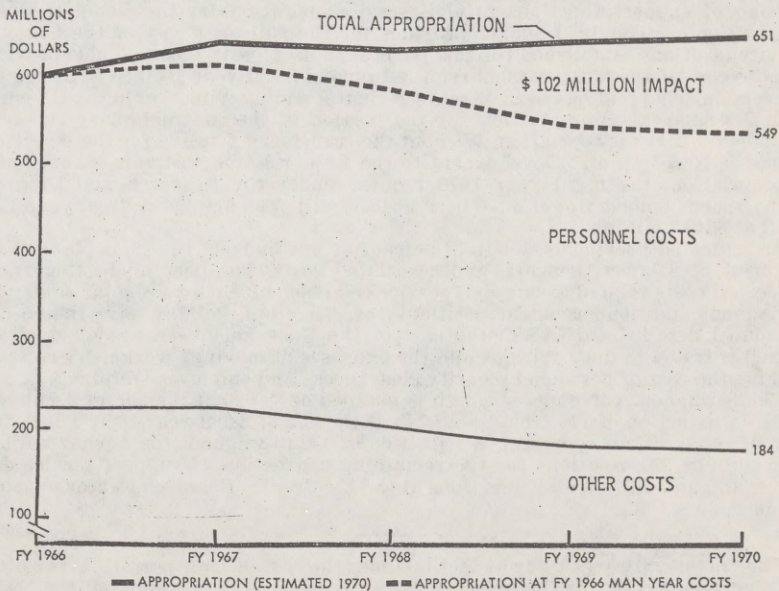
RESEARCH AND PROGRAM MANAGEMENT, DISTRIBUTION BY FUNCTION

[In millions of dollars]

	Fiscal year 1968	Fiscal year 1969	Fiscal year 1970	Change in fiscal year 1970
Personnel related costs.....	432.3	463.7	469.5	+5.8
Travel.....	15.1	14.6	14.6	-----
Automatic data processing.....	32.0	24.6	23.8	-.8
Facilities services.....	94.3	85.9	85.0	-.9
Technical services.....	20.5	17.4	16.9	-.5
Administrative support.....	45.1	42.0	41.1	-.9
Total.....	639.3	648.3	650.9	+2.6

The next chart is a table that describes the major cost categories. As you can see the major item is for the personnel related cost, and the increase in our budget is directly related to that item. That increase, I should mention, is related primarily to increases in salary. With our present on-board strength if we were still paying at the rate that existed back in fiscal year 1966, our total research and program management budget would be about \$100 million less than the fiscal year 1970 level shown on this chart. In other words, it would be about \$549 million rather than the \$650.9 million as shown.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
IMPACT OF GOVERNMENT WIDE SALARY INCREASES ON
THE "RESEARCH & PROGRAM MANAGEMENT" APPROPRIATION LEVELS



The next highest category in the chart is the Facilities Services Cost for the operation of our facilities, electric power for wind tunnels, for space simulators, also the support operations at the Cape, certain minor construction, etc.

At this point I should point out we have introduced in our appropriations a new item which for the first time recognizes on an agency-wide basis the problem we have in accomplishing the necessary rehabilitation work to protect and preserve the capability and usefulness of our physical plant. We have included a \$9 million item for rehabilitation and alteration work in our Construction of Facilities program. This work, characterized as capital-type rehabilitation that should be done to protect our plant investment, is different from the normal maintenance, repair and modifications carried out under the Facilities Services category of the Research and Program Management appropriation. I mention this item since it covers work across all of our NASA Centers, as does the extremely important category of Facilities Planning and Design, and it does not fall under any one of the Subcommittees.

Now, for the sake of time, we might skip to the bottom of page 13, which summarizes my comments on the Research and Program Management budget. The specific cost elements shown on the chart are described in the full statement that we have submitted for the record and I am prepared to answer questions on that subject if you wish.

However, to summarize my RPM statement—in the interest of time—I will now start at the bottom of page 13.

(Those portions of Mr. Finger's Summary Statement which were not read are as follows:)

PERSONNEL RELATED COSTS

The single reason for the increase in the Research and Program Management appropriation over the fiscal year 1969 level is the cost associated with the conversion of support functions to civil service operations at the Goddard Space Flight Center. The 1970 budget provides for the full year cost of the 559 civil service positions established for this purpose in fiscal year 1969 and also provides for the cost of the 251 positions required during fiscal year 1970 to complete the conversion. This cost has been offset by a corresponding reduction in the Research and Development appropriation for the portion of the contracts that had been included in that appropriation. Without the transfer of funding for these services from the Research and Development to the Research and Program Management appropriation, the fiscal year 1970 request under the Research and Program Management budget would have been \$645.5 million as against a fiscal year 1969 total of \$646.7 million.

As indicated previously about 72 percent of our budget request is planned for payment of salaries, benefits, and associated costs. The personnel category includes all costs related to our civil service complement, such as regular salary for permanent and nonpermanent positions; overtime and holiday pay; the cost of personnel detailed to NASA; the cost of the Government's share of employee benefits; travel to duty stations and the expenses of moving; workmen's compensation; the cost of personnel security clearances; and employee training.

The permanent personnel strength is planned at 31,600 at the end of fiscal year 1970—a reduction of 145 from the 31,745 at the end of fiscal year 1969. The reduction of 145 positions represents a reduction of 452 throughout the Agency with an offset of the 251 positions for the remaining conversion of support service contracts and an addition of 56 positions at the Electronics Research Center to attain a minimum staffing level.

TRAVEL

The travel category of our budget includes the cost of transportation, per diem, and incidental costs for the travel of NASA employees in carrying out the NASA program. As in the past, about three-quarters of our travel is directly related to

direction, coordination and management of R. & D. and COF programs, flight mission support and overseas travel to tracking and launch sites. The remainder of the cost is for participation in meetings and technical seminars and for travel and coordination of general management functions. The total travel estimate for fiscal year 1970 is \$14.6 million, about the same as in fiscal year 1969.

AUTOMATIC DATA PROCESSING

The automatic data processing category in Research and Program Management provides for the lease, purchase, maintenance and operations of general purpose equipment which support overall operations common to research and development programs, facilities and business administration. The Research and Development and Construction of Facilities appropriations provide for the automatic data processing systems and operations which are dedicated to specific programs or projects or are included in specific program facilities. In addition, large computer complexes consisting of several systems which are primarily designed for use in direct support of R. & D. activities and are to be acquired over a period covering more than 1 fiscal year will be funded under the Research and Development Appropriation. The distribution of ADP equipment by funding appropriation is included in Volume I of the Fiscal Year 1970 budget estimate.

We are requesting \$23.8 million in the Research and Program Management appropriation in Fiscal Year 1970—a reduction of \$0.8 million from the Fiscal Year 1969 plan. The reductions, in the main, result from reduced lease costs of \$0.6 million and reduced programing and operating services of \$0.2 million. These reductions are largely the effect of the release of older equipment with the installation of third generation equipment, and the reduction of the overlap in software costs while programs were being developed for the third generation equipment.

FACILITIES SERVICES

The fund requirement for facilities services is the second largest increment of the Research and Program Management appropriation. The costs included in this category include general operating and maintenance expenses of the NASA physical plant. The largest part of the costs are in direct support of the research and development programs. For example, the utilities for operating our laboratories, wind tunnels, and research facilities are included. Also included are rental of facilities, alteration, repair and minor construction, maintenance and related services for our buildings and equipment, and operation of our facilities. We have included in this category the entire cost of the range operations contractual effort at the Merritt Island Launch Area and the reimbursement to the Air Force's Eastern Test Range for general services provided to the Kennedy Space Center funded from this appropriation.

For the total facilities services category, the estimate of \$85 million in Fiscal Year 1970 is \$0.9 million less than for Fiscal Year 1969. The decrease is primarily related to reductions at the three Manned Space Flight Centers, totaling \$1.6 million, of which the largest individual reductions are \$0.5 million at MSC because of a reduction in the level of activity at the White Sands Test Facility and \$0.5 million at the Kennedy Space Center resulting from the phase down of Saturn IB launch activity at Launch Complexes 34 and 37 and related facilities at the Cape Kennedy Air Force Station. These savings are partly offset by an increase of \$0.8 million associated with operations at the Electronics and Ames Research Centers. At ERC, additional funds are required to move into new, permanent facilities at the Electronics Research Center and for the operation and maintenance of these facilities. At Ames Research Center, funds are provided for increased electricity usage for wind tunnels and a better level of maintenance and custodial services. The other centers plan a net decrease in this area.

TECHNICAL SERVICES

The support to the direct program effort which is funded from Research and Program Management includes certain categories of technically oriented services. These have been grouped together under the category of Technical Services, with subcategories of Engineering Services and Scientific and Technical Information and Education programs.

Engineering services include the cost of reliability and quality assurance training, the preparation of guidelines for reliability requirements and methods,

and special engineering designs and studies. The scientific and technical information program provide for the support of installation technical libraries, the acquisition and dissemination of scientific and technical literature. The estimate for Fiscal Year 1970 is \$16.9 million, a reduction of \$0.5 million from Fiscal Year 1969.

ADMINISTRATION SUPPORT

The remainder of our Research and Program Management appropriation can be described generally as administrative support. The cost of the support provided under this category amounts to less than 7 percent of the total appropriation level. The estimate for Fiscal Year 1970 is \$41.1 million, \$0.9 million less than in Fiscal Year 1969.

The largest part of this category is the cost of administrative communications, including cost of leased lines, long-distance tolls (both through the Federal Telecommunications System and commercial), local telephone exchange services, and other communications costs such as TWX, telegraphic services, and postage.

The balance of the costs relate to overall installation operations and include administrative printing and reproduction, supplies, materials and equipment, transportation, and administrative support services, such as medical, supply and mail and messenger services. The reduction in the cost for this total category of \$0.9 million in Fiscal Year 1970 as compared with fiscal year 1969 results from the continuation into Fiscal Year 1970 of the concerted effort on the part of NASA installations to reduce their administrative costs to the lowest possible level.

Mr. FINGER. To summarize this area of my presentation NASA has made major reductions in the Research and Program Management budget. We are convinced that our Fiscal Year 1970 budget request is as low as is possible, and that any further reduction would seriously hurt our ability to carry out the programs requested. There are significant manpower needs throughout the agency in order to carry out the programs we have proposed and are carrying out; our people are being pressed to limit their manpower demands. It is difficult to maintain a balance under the attrition modes that have been set for separations and with the strict limitations we have on manpower ceilings; and perhaps most important, under these manpower ceiling limitations, we can't hire young college graduates—scientists, engineers, administrative people—who would serve as the developing force to maintain the high competence of our laboratories in the future.

By NASA's reliance on industry and universities to carry out most of the research, development, and operations work involved in the aeronautics and space program, NASA has kept its staffing requirements down to the minimum levels necessary to carry out the essential Government functions with minimum variations even over periods of fluctuating work activity. This includes the use of support contracts with industry to carry out certain of those functions at NASA installations that do not compromise the basic NASA requirement that Government employees must be responsible for the major decisions, specification of goals, evaluation of program status and contractor performance, selection of methods of carrying out the work, and overall management of the work. We believe that this has been and is an effective operating system but that we have gone as far in this direction as it is wise to do, so that any further reductions in civil service manpower beyond those indicated in the budget before you would seriously hurt our ability to successfully accomplish our program and will greatly diminish the national resource of competence provided by these people and our inhouse facilities.

UNIVERSITY PROGRAMS

I would like now to turn to our programs with universities, which continue to be an essential partner, with Government and industry, in the aeronautics and space effort. They have done much to advance our understanding of the space environment. They have trained thousands of men and women. University scientists and engineers have undertaken research in campus laboratories; they have provided over 50 percent of our flight experiments and have published almost 75 percent of the space science reports. This relationship with universities has been essential to the accomplishment of NASA's mission and we believe has been equally beneficial to the universities. NASA has benefited from the space experiments, the new scientific concepts and the new technologies developed by universities; university professors and graduate students have benefited by their participation in the acquisition of new knowledge from space research.

NASA's university program has two parts: (1) project-oriented grants and contracts awarded by our program offices and field centers to get university help in accomplishing the ongoing NASA research and flight projects, and (2) grants made under the NASA Sustaining University Program to aid universities in developing their own strengths while undertaking research on NASA's longer range educational and research goals. The Sustaining University Program, therefore, provides a means for drawing on the full capabilities and originality of the universities in NASA's future activities.

About 200 universities in all the States participate in the NASA program. There are about 1,300 project-oriented research grants and contracts now in effect which, in Fiscal Year 1969, amount to almost \$100 million for the year. Under these grants and contracts, for example, 32 universities in 20 States are now working with NASA on various aspects of the earth resources satellite program. Eighteen universities are working on 51 experiments for the Orbiting Geophysical Observatory (OGO) satellite program. Forty-six universities in 23 States are working on materials technology, and 47 universities in 23 States are working on flight medicine and biology. Over 900 university experimenters are now working on preparation of the experiments or on analysis of data from NASA's balloon, sounding rocket and satellite and deep space flights. One hundred thirty-four principal scientific investigators and 182 coinvestigators from 42 universities are preparing to analyze lunar samples to be returned from the Moon by the Apollo astronauts.

The university participation in this project work has indeed been essential in successfully accomplishing our mission objectives.

In addition, through the Sustaining University Program, we have tried to encourage the development and application of university capabilities to permit even more effective participation in our aeronautics and space science and technology research activities in the future.

From 1959 through Fiscal Year 1968 about \$204 million (about 30 percent of NASA's total funding at universities) has gone into research, training and facility grants made under the Sustaining University Program. Between Fiscal Years 1963 and 1968 NASA made 37 facility grants to 34 institutions providing \$44 million which

represents about half the cost of new aerospace facilities at these institutions. In Fiscal Year 1968, 50 universities were being supported under NASA sustaining research grants. With the reduced budget levels available, only 30 of these universities will be awarded additional funds in Fiscal Year 1969.

NASA has awarded a total of 5,400 3-year predoctoral training grants; nearly 1,700 trainees have already received their Ph. D.'s. The original intent of this program was to help to replenish the national supply of Ph. D.'s by producing 1,000 new Ph. D.'s per year. Funding limitations made it necessary to reduce the number of new traineeships in Fiscal Years 1968 and 1969 to 45 per year; these were concentrated in the public administration, management, and engineering systems areas. In addition to the 45 new predoctoral traineeships that are provided in our Fiscal Year 1970 Budget, we are now arranging for about 140 universities to use training funds that were previously obligated to them, but were not expended, to provide support equivalent to about 350 additional predoctoral 3-year traineeships. The increase will be initiated with the Fall 1969 semester.

Our Fiscal Year 1970 request for the Sustaining University Program is \$9 million, the same as in Fiscal Year 1969. We plan to continue on-campus multidisciplinary research at a reduced level; we will continue to encourage close working relationships between universities and our NASA field centers and will try to make NASA facilities available for greater use by university professors and graduate students; we plan to continue our pilot research and training programs in public administration, management, and engineering systems design.

Under the present fiscal constraints, we feel that our current plans provide only a holding action that takes advantage of step funding stability in existing grants, stretching out some programs and limiting new opportunities. This is, at best, a temporary solution to both NASA's and the universities' need for long range stable support in research and education. We are concerned that under this plan, we will be unable to meet our long range needs for highly trained people in specialized areas such as remote sensing, lasers and optics, aeronautics, and acoustics. We are now deferring many opportunities to support imaginative and innovative university programs that encourage the building of new capabilities in regions and institutions where the potential now exists. Because of these severe limitations, we are working, within our total budget availability, to find ways of increasing our university support for training and research during the remainder of Fiscal Year 1969 and in Fiscal Year 1970.

The Sustaining University Program will be discussed in detail by Mr. Francis B. Smith, Assistant Administrator for University Affairs, in his testimony before the House Subcommittee on Space Science and Applications and he is available here if the Committee wishes to have him comment on any specific issues in this area.

TECHNOLOGY UTILIZATION

Turning now to the Technology Utilization Program, that is an experimental program designed to explore and develop practical ways of transferring new aerospace technology to such diverse nonaerospace

fields as law enforcement, education, air and water pollution, health care, automotive and aircraft safety, and many other industrial areas. By encouraging the additional uses of aerospace technology in such nonaerospace fields, an additional return may be realized on our investment in aeronautical and space activities. We believe that the original program assumptions are validated by the transfer of new technology in an increasing volume to nonaerospace industry, universities and other users.

The President's budget for Fiscal Year 1970 requests \$5 million for the Technology Utilization Program; the same amount as was authorized in Fiscal Year 1967 and an increase of \$1 million and \$1.2 million over the amounts authorized in Fiscal Year 1968 and 1969 respectively. The increase of funds will provide for some increased effort to develop specific new technology identification techniques and methods which will serve to accelerate and increase the identification and reporting of significant NASA developments in such important areas as computer software and advances in biomedical instrumentation with a high potential of further applications.

The Technology Utilization Program now has in operation six university based Regional Dissemination Centers transferring aerospace technology to industrial clients; three research institute based multidisciplinary Biomedical Applications teams transferring aerospace technology directly to biomedical researchers in medical institutions, and a Computer Software and Management Information Center disseminating and transferring directly to industry computer programs developed by NASA and the Department of Defense. These existing dissemination and transfer mechanisms will be expanded to allow them to capitalize on new opportunities to transfer knowledge to new users.

We are also broadening our activities with other agencies and working to apply the approaches we are developing to their needs.

We are currently cooperating with the Department of Defense by making available to industry NASA and DOD computer software through the Computer Software and Management Information Center and the unclassified technical data on magnetic tapes at the Defense Documentation Center through our Regional Dissemination Centers. In order to achieve overall economies, we are working jointly with the Atomic Energy Commission to make available, through our Technology Utilization publications, the AEC's technical innovations. We recently concluded final arrangements to provide the services of one of our Technology Applications Teams to the National Air Pollution Control Administration to assist them in identifying air pollution problems which may be solved by aerospace technology and then systematically searching the aerospace data bank for solutions to those problems. The Applications Teams are also working closely with the Social Rehabilitation Service to apply aerospace technology to solution of medical problems. In a cooperative program with the Law Enforcement Assistance Administration the NASA Applications Team at the Research Triangle Institute in Durham, N.C., recently completed a police personnel communications systems study based on aerospace communications technology. We are planning additional interagency cooperative efforts with other agencies, such as the Federal Water Pollution Control Administration, the Department of

Transportation and the Department of Housing and Urban Development to use the basic transfer mechanisms and capabilities that NASA has developed and funded. This will allow the matching of technical problems identified by those agencies with aerospace data in order to achieve possible solutions to those problems.

The Technology Utilization Publications Program is being strengthened to insure that significant new technological developments are documented and made available to industry and universities. Nearly 20 highly significant technical documents on such subjects as nondestructive testing, bioinstrumentation, and application of systems analysis models were published last year and it is anticipated that nearly 25 more will be published this year.

We believe that these approaches do offer real opportunities for added benefits and "return on our investment" from our aerospace programs.

The transfers of aerospace knowledge to other fields are numerous. Dr. Mueller yesterday mentioned several that I think were quite illustrative. I have listed a few other examples in my prepared statement. I will mention two of those here.

Infants or comatose children or adults sometimes require a tracheotomy tube surgically implanted in the windpipe to ease breathing. If the tube clogs—which it often does, cutting off breathing—if there is not an attendant ready and available to spot the trouble, brain damage or death can result in 2 to 4 minutes. A full-time nurse is required to check the tube visually. Integrated circuitry designed and fabricated for aerospace use by NASA Ames Research Center has been modified to note differences in temperatures of air passing through the tube and actuate an audible or visible alarm within 10 seconds of any change. The signal can be given at a nurse's station or be shown in another room if the patient is at home.

Aerospace technology may play a part in reducing radiation hazards for those patients who must be treated with radioactive iodine. An iodine isotope, iodine-123, may reduce the radiation dose, when used with the proper equipment, by a factor of almost 10,000. The isotope would replace the reactor-produced isotope iodine 131. Cost of preparation of the iodine-123 had limited its use in diagnosis and treatment. Now, an economical method for its preparation, developed by the Lewis Research Center in conjunction with the Department of Health, Education, and Welfare, has been developed. The details concerning the method were summarized in a technology utilization publication.

A management technique called "Vis-A-Plan" used to maintain control over engineering and development projects and some production activities was developed by an aerospace company for Kennedy Space Center and has been adapted by a small business. The company employs 600 persons, performs work for a variety of customers, and has adapted the Kennedy program to manage and control engineering projects where there had been problems with cost and time overruns. The only staff time required, according to the company, is that of a clerk who posts the results and the data received. Called "a tool we can trust" by the division manager, the plan has speeded engineering output, and has cut costs by 10 percent. The company learned of the charting method through a technology utilization publication.

A NASA-developed technique for detecting voids or poor bond lines in fiberglass laminates is of interest to widely varying industries. The procedure is to apply a thin coating of a commercially available liquid crystal solution. When the sample is heated, defect locations are shown by differences in color on the surface due to the variations in heat. A chemical firm believes that production of resistant coating should be improved when the technique is perfected for its use. An electronics firm is adapting the method to its fiberglass laminate production for circuit boards. A brake manufacturer reports the method to be potentially valuable in its work. A helicopter maker is evaluating the procedure for testing the integrity of bonded panels. And a building products maker believes the technique can be used to monitor the quality of wallboard during the manufacturing process; there had been no satisfactory method of determining the distribution of voids within wallboard.

These examples have been related to illustrate a very important experimental process which is going on to generate the bonus returns on our involvement in aeronautics and space programs.

Dr. Richard L. Leshner, the Assistant Administrator for Technology Utilization, will be describing this program in detail in the hearings before the Subcommittee on Advanced Research and Technology and he is also available here to take part in any discussion of this area that you may desire.

Thank you very much.

Mr. TEAGUE. Dr. Naugle.

(A biographical sketch of Dr. John E. Naugle, Associate Administrator for Space Science and Applications, is as follows:)

DR. JOHN E. NAUGLE

Dr. John E. Naugle is Associate Administrator for Space Science and Applications in NASA headquarters. As head of the Office of Space Science and Applications, Dr. Naugle administers the following NASA program areas: Bioscience, communications and navigation, lunar and planetary, meteorological, manned space science, grants and research contracts, geophysics and astronomy, and launch vehicles and propulsion.

Before assuming his position as Associate Administrator for OSSA in October 1967, he was Deputy Associate Administrator for Space Science and Applications (Sciences). He was assigned this post in May 1966.

Dr. Naugle was responsible for the overall scientific program of the Office of Space Science and Applications including its supporting research and technology. He was also responsible for the overall planning of the OSSA program and for coordinating the OSSA plans with those of the other major elements of NASA.

From June 1962 until May 1966 he was Director of Physics and Astronomy programs in the Office of Space Science and Applications. As such he was in charge of those programs which use spacecraft and sounding rockets to explore the Earth's environment, study the Sun and make astronomical observations.

Prior to that he served for a year as Chief of Physics, Physics and Astronomy programs, Office of Space Sciences. His NASA service began in 1959 when he became Head of the Nuclear Emulsion Section at Goddard Space Flight Center. From 1956 to 1959 he was Senior Staff Scientist at the Convair Scientific Research Laboratory, San Diego, Calif.

Dr. Naugle was born February 9, 1923, in Belle Fourche, S.D. He earned a B.S. degree in Physics in 1949, M.S. in 1950 and Ph. D. in 1953 at the University of Minnesota. He was a research associate and physics instructor at the university from 1953 to 1956.

Dr. Naugle is the author of several scientific and technical papers and is a member of the Physical Society, American Institute of Aeronautics and Astronautics, and Sigma Xi.

Dr. and Mrs. Naugle and their three children live at 7211 Rollingwood Drive, Chevy Chase, Md.

**STATEMENT OF DR. JOHN E. NAUGLE, ASSOCIATE ADMINISTRATOR
FOR SPACE SCIENCE AND APPLICATIONS, NATIONAL AERONAU-
TICS AND SPACE ADMINISTRATION**

Dr. NAUGLE. Mr. Chairman and members of the committee. It is an honor and a pleasure to review the NASA Space Science and Applications program for the Committee on Science and Astronautics. With your permission, I would like to present a summary of the statement which I have submitted to the record.

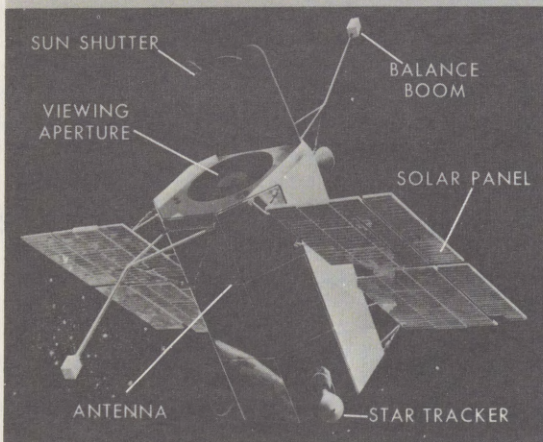
(The complete prepared statement of Dr. John E. Naugle will be found in the Subcommittee on Space Science and Applications hearings.)

Dr. NAUGLE. To continue with my summary statement.

The Office of Space Science and Applications (OSSA) is responsible for the exploration of the solar system and the observation and study of the stars and galaxies. We use the knowledge and technology of aeronautical and space flight to develop and test space systems to help solve mankind's practical problems in such fields as communication, navigation, weather prediction, and the survey and evaluation of our natural and cultural resources. We are also responsible for providing launch services for NASA's automated spacecraft, and on a reimbursable basis, for spacecraft of the Environmental Science Services Administration (ESSA) of the Department of Commerce, the Communications Satellite Corporation (COMSAT), and a number of foreign countries.

We will review the OSSA program for fiscal year 1970 against the background of a year of unprecedented achievements for NASA, climaxed by the historic voyage of Apollo 8 to the moon and the successful launch of an Orbiting Astronomical Observatory, OAO-II (chart SG69-271). These two launches, so close in time—the one

ORBITING ASTRONOMICAL OBSERVATORY

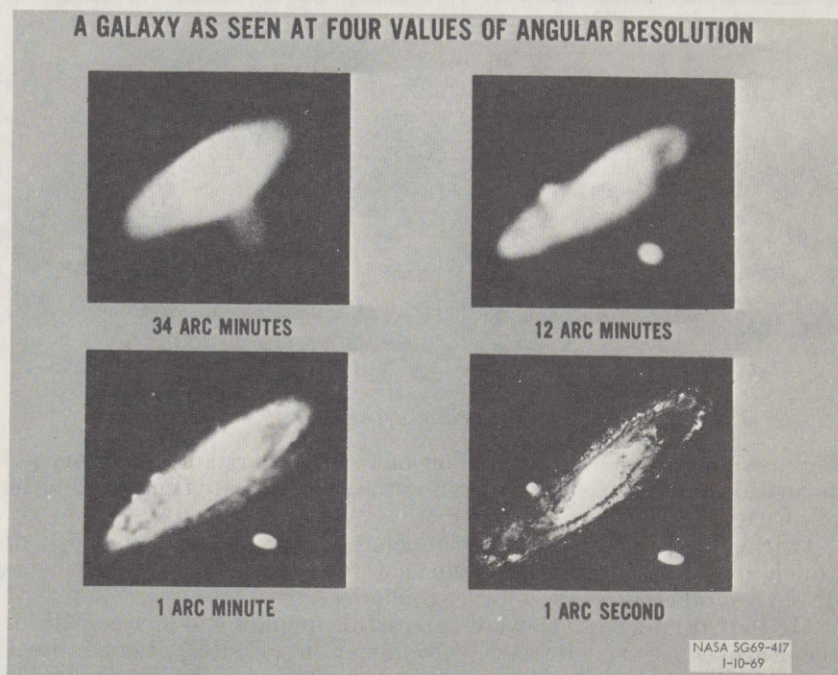


GROSS WEIGHT	- 4400 LBS.
INSTRUMENT WEIGHT	- 1000 LBS.
INSTRUMENT DIAMETER	- 42 INCHES
STABILIZATION	- ACTIVE 3- AXIS
POINTING AXIS	- 0.1 ARC SECOND
ORBIT	- CIRCULAR 480 S. MI. INCLINATION 35°
LAUNCH VEHICLE	- CENTAUR

giving man the ability to leave the Earth and begin his personal exploration of the solar system, and the other giving him an entirely new set of tools to observe the universe—will become landmarks in the evolution of human knowledge.

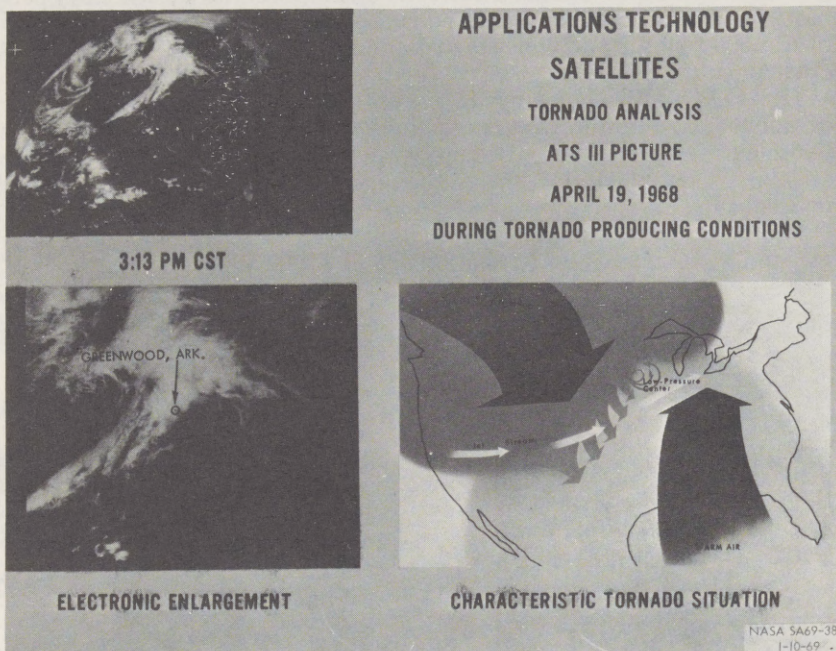
The launch and continuing successful operation of OAO-II was the major scientific and technological achievement in the OSSA program in 1968. The Orbiting Astronomical Observatory which is perhaps the most complex automated spacecraft ever constructed, weighs over 4,000 pounds and consists of more than 238,000 individual spacecraft parts.

The OAO-II is pointing 11 telescopes at stars with an accuracy of about 1 arc minute. Later versions of the OAO will point single telescopes 3 feet in diameter at stars with an accuracy of 0.1 arc second. Chart SG69-417 shows the significance of this improvement in resolution.



If you will reflect for a moment upon the impact of astronomy on mankind since Galileo—of how the knowledge of astronomy has changed man's concept of the universe—of the practical contributions astronomy has made to the measurement of distance and time, of the fact that it was astrophysicists puzzling over the source of energy in stars which ultimately led to the understanding and practical application of nuclear energy, and reflect that astronomers are in a ferment today puzzling over the tremendous sources of energy which appear to power the newly discovered quasars and pulsars—if you ponder all these things carefully, I am sure that the Members of this Committee are proud of their vision and their support to this program over the past decade without which OAO would not have been possible.

The use of the Applications Technology Satellites (ATS) I and III to study severe weather phenomena was a significant practical application of space technology in 1968. ATS-III, in a stationary position over the equator, due south of the United States, continuously photographed the Earth during periods of high tornado probability. (Chart SA69-381.) The ATS-III pictures show that sequential large-scale



pictures can make a major contribution to the understanding of tornado formation, and can be used to predict the approximate times and paths of tornadoes.

OSSA was responsible for 20 launches in 1968 (chart SV69-370) of which 9 were OSSA missions and 11 were missions for other elements of NASA, other agencies, or other countries.

Of the 20 launches, 17 were successful, including 3 spacecraft for the European Space Research Organization (ESRO). Our failures involved three different launch vehicle systems: Thor Agena in the case of Nimbus B, Atlas Centaur in the case of ATS-IV, and Thor Delta in the case of the International Telecommunications Satellite Consortium—INTELSAT III-A—in each case the failure followed an extended series of successful launches of the same vehicle system. The reviews have revealed no connection between the failures, but have resulted in successful corrective actions, as shown by subsequent successful flights of each of the launch vehicle systems.

The recovery from loss has been different for each mission. The Nimbus B mission was so unique and important that the decision was made to fly a duplicate mission (Nimbus B-2). By using available spares and prototypes, restricting all engineering changes, and through a maximum effort on the part of NASA's Goddard Space Flight

Center and the contractor (General Electric), we plan to fly Nimbus B-2 in April 1969, barely 11 months after the Nimbus B failure.

While the ATS-IV mission was equally important, we can achieve most of the objectives of that mission with ATS-E, which is scheduled for a mid-1969 launch. Therefore, we are not planning to replace ATS-IV.

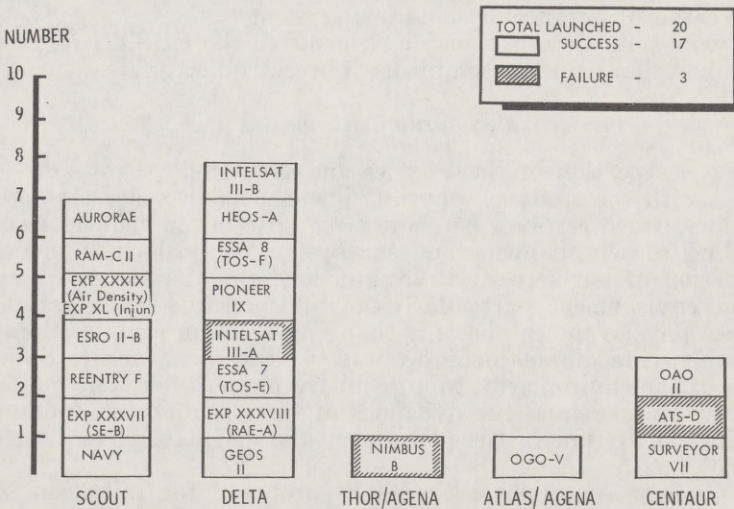
Three months after the INTELSAT III-A failure, COMSAT initiated its new system with the successful launch of INTELSAT III-B.

I will now review our plans for calendar year 1969 and describe the program we are asking you to support in fiscal year 1970.

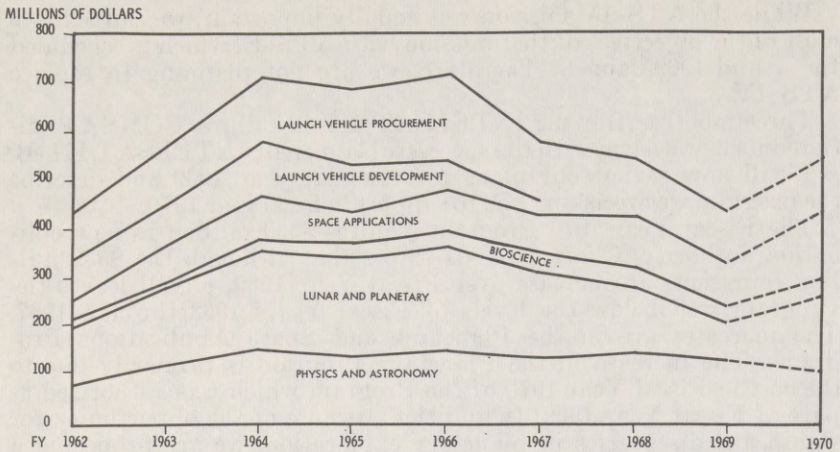
The Fiscal Year 1970 Program requires \$559 million in new obligation authority. Chart S67-604 shows that although the \$559 million represents an increase over Fiscal Year 1969, it still leaves the Program well below the levels of Fiscal Years 1963 through 1967. The increases are in the Planetary and Space Applications Programs. The increase in the Planetary Program is primarily due to the cost in Fiscal Year 1970 of the Program which was authorized as part of Fiscal Year 1969. In addition, because of the opportunity for significant discoveries in planetary exploration, we are proposing a Planetary Explorer Program and a dual planet mission to Venus and Mercury for 1973. The increase in the Space Applications Program is for an experimental Earth Resources Technology Satellite (ERTS) and a prototype of an operational Synchronous Meteorological Satellite (SMS).

Although our budget increases, it is still an extremely tight budget. We are far from doing all this Nation can do in the way of the scientific exploration of space or in the practical application of space tech-

1968 LAUNCH VEHICLE RECORD



SPACE SCIENCE AND APPLICATIONS FUNDING HISTORY



NASA 567-604
REV 1-15-69

niques. For instance, we have no launchings to Venus this year, even though such a mission was strongly recommended by the Lunar and Planetary Missions Board, and even though the Russians continued their systematic exploration of that planet by launching two spacecraft to Venus in January 1969. We have deferred a start of additional Orbiting Astronomical Observatories after OAO-B and C, even though the success of OAO-II clearly demonstrates the potential in that area of research. Late in 1968, we canceled two Biosatellite missions and we deferred design studies on satellites for the World Weather Program and a data relay system.

I will now summarize the major elements in the OSSA Program and show how they help to accomplish our overall objectives.

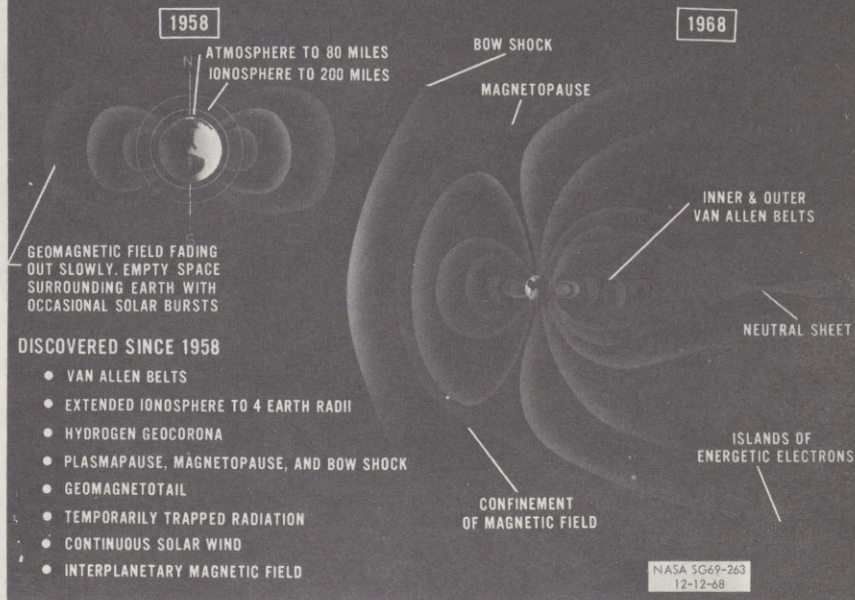
PHYSICS AND ASTRONOMY PROGRAMS

The physics portion of the Physics and Astronomy Programs is concerned with the study of physical phenomena in space through observations which can best be made from spaceborne vehicles such as sounding rockets, balloons and spacecraft. Its goals include the determination of our terrestrial environment and the forces which shape that environment, particularly the influences of solar radiation.

In space physics the emphasis is changing from an early exploratory phase, where our major effort was to develop an accurate description of the environment, to a definitive phase, where our major efforts are to understand the dynamics of the environment, such as the origin and lifetime of the particles in the magnetosphere (chart SG69-263).

The only new space physics missions proposed for initiation in Fiscal Year 1970 are two Scout-sized Explorers to study the dynamics

DECADE OF ACHIEVEMENTS IN SPACE PHYSICS THE ENVIRONMENT OF THE EARTH



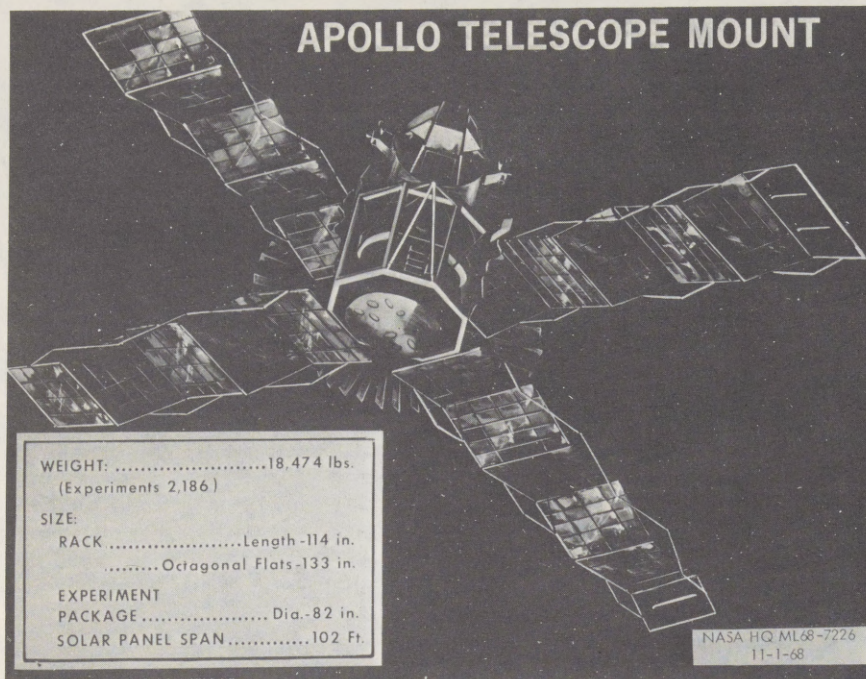
of the magnetosphere, and two Explorers to study the atmosphere at altitudes of 100 miles, a region which has not been explored by satellites before.

The goal of the astronomy portion of the Physics and Astronomy Programs is to understand the basic processes and phenomena in the universe; in particular, the composition, structure, and physical properties of the Sun, the other stars, and the galaxies.

In the space Astronomy Program we will use the Radio Astronomy Explorers, which Dr. Paine mentioned yesterday, to continue studies in the long wave radio regions of the spectrum. The development of the Small Astronomy Satellite (SAS) was initiated in Fiscal Year 1969 to fill the serious gap in capability between sounding rockets and the highly sophisticated OAO. The first mission, a survey of stellar X-ray sources, is proceeding toward a launch in 1970, and the second mission, a survey of gamma-ray sources is planned for a launch about 1971. In Fiscal Year 1970 we are requesting funds for two additional SAS missions, SAS-C and D, for flights in 1972 and 1973. These spacecraft will provide a second generation X-ray survey mission and a high-resolution ultraviolet spectrometry experiment to study atmospheres of brighter planets.

In the Observatory Class of satellites we are proceeding with preparations for the launch of the second OAO in late 1969 or early 1970, and the third in OAO in 1971. Two additional Orbiting Solar Observatories are now under test and development for launch late this year and early in 1971. In the Fiscal Year 1970 budget we are requesting funds for OSO I, J, and K to continue the study of the Sun.

APOLLO TELESCOPE MOUNT



WEIGHT:18,474 lbs.
(Experiments 2,186)

SIZE:

RACKLength-114 in.
.....Octagonal Flats-133 in.

EXPERIMENT

PACKAGEDia.-82 in.

SOLAR PANEL SPAN102 Ft.

NASA HQ ML68-7226
11-1-68

The Apollo Telescope Mount (ATM), (Chart ML 68-7226) funded by the Office of Manned Space Flight is an important element of NASA's Astronomy Program. My office is responsible for establishing the Space Science and Applications objectives of manned missions and for selecting the experiments and experimenters to accomplish those objectives. The ATM will obtain wide spectral coverage of solar radiation, high time-resolution of variations in that radiation and high spatial resolution of the events on the surface of the Sun. In addition, ATM enables NASA to investigate the effectiveness and proper role for man in future astronomical programs.

The long-range objective of the space Astronomy Program is to establish, by a series of evolutionary steps, permanent astronomical observatories in space. In the years immediately ahead we will be using both automated and manned systems to conduct astronomical observations which will give us not only scientific data but also the practical experience we need to plan the permanent observatories and determine their proper location and mode of operation.

I turn now to the Lunar and Planetary Programs.

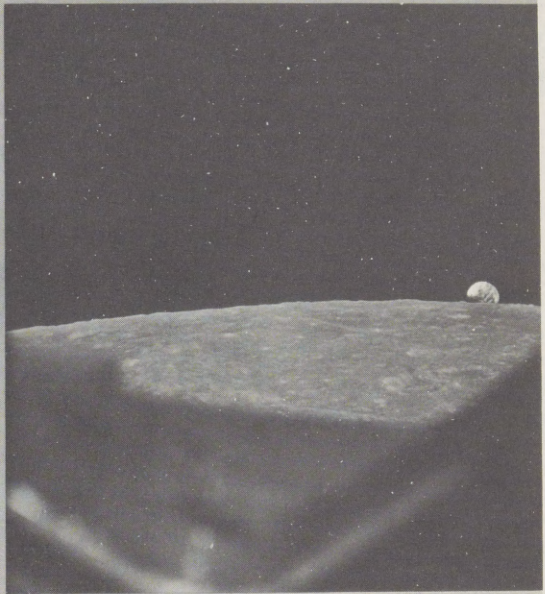
The goal of the Lunar and Planetary Programs is to understand the origin and evolution of the solar system, the origin and evolution of life in the solar system, and most importantly, the dynamic forces that shape man's environment on Earth.

Why are these goals important? Certainly, one of the most important reasons for exploring the solar system is the satisfaction of the fundamental drives which man has to explore his environment

and to understand that and master that environment. Society must be able to provide an outlet for those drives if it is to remain a healthy society. The voyage of Apollo 8 to the Moon, with its view of the Earth as a beautiful oasis in the vastness of space (Chart S69-514) helped for a moment to unite a torn and troubled world.

Another important reason for exploring the solar system is the knowledge and understanding that it will bring to a solution some of the problems of preserving and protecting our world. We know that man, through industrial revolution and an increasing population, is not only polluting the atmosphere but may be actually changing its very nature. We also know that there have been major climatic changes in the past, but we do not understand the reasons for those changes. We do not even know for sure whether our atmosphere is slowly warming or slowly cooling. Our meteorological satellites and atmospheric explorers are giving us invaluable insight into our atmosphere but with them we can only study that atmosphere as it is today, not as it was or as it may become. Nor do we want to conduct large scale experiments on the Earth's atmosphere to attempt to get a better insight into the processes at work. However, in a detailed investigation of Mars and Venus we can study the properties of planetary atmospheres quite different from those of the Earth. A comparison of the properties of these atmospheres and an understanding of why they are different will give atmospheric physicists a new body of knowledge and a new perspective from which to tackle the problems mankind will face on Earth in the decades ahead.

ASTRONAUTS VIEW OF THE EARTH OVER THE LUNAR HORIZON

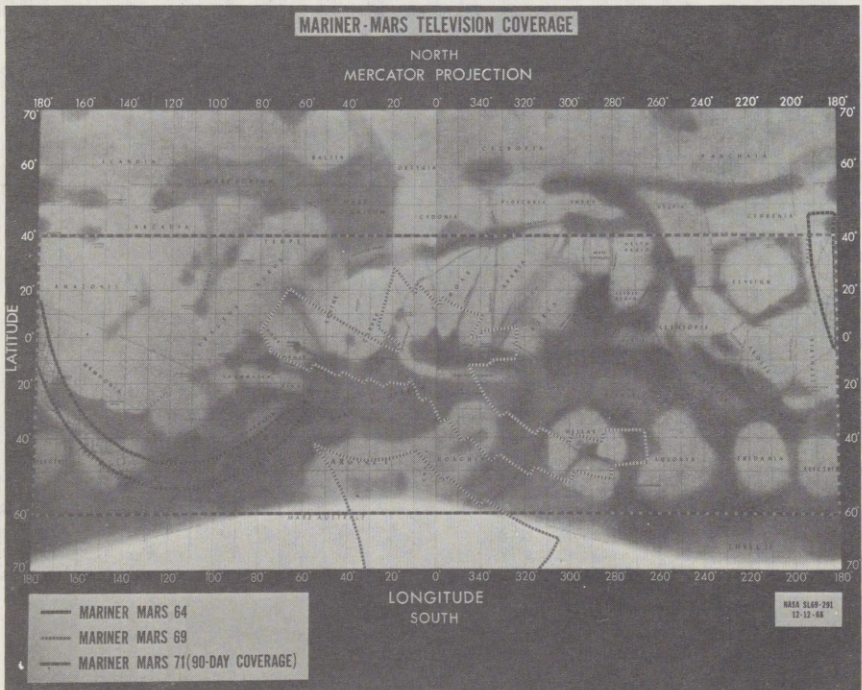


NASA 569-514
1-29-69

The Fiscal Year 1970 Planetary Program represents the early phases of a "balanced" strategy—a strategy which provides for the broad-based exploration of several planets in an orderly manner over a period of time combined with detailed measurements on the surface of Mars. A key element of such a balanced strategy is that the detailed systematic exploration of Mars will be emphasized, but will not preclude the study of Venus, Mercury, and Jupiter.

The Mars exploration program, a Fiscal Year 1969 authorization, is proceeding in a stepwise manner toward the exploration of Mars with an orbiter/lander combination. The major activity this year will be the launch of two Mariner flybys in February and March 1969. As Dr. Paine noted yesterday, Mariner VI, built by the Jet Propulsion Laboratory, is well on its way to Mars. The scientific studies to be performed include a comprehensive determination of atmospheric composition, particularly the amount of nitrogen in the Martian atmosphere. In addition, surface features will be observed with a television camera having a resolution as great as 100 meters, which is 10 times better than the Mariner IV camera resolution in 1965. (Chart SL69-291.) Equally important will be the contribution of these missions to the planning of the 1971 orbiter missions and the selection of the scientific investigations to be performed on the 1973 soft landers/orbiters.

The Viking Program was described in our Fiscal Year 1969 testimony as a Titan Mars Orbiter-Lander. In December of 1968 we decided that this mission would be a combination of a Mariner 71 orbiter and a soft lander similar to a Surveyor. We will launch two of these com-



bined orbiter-lander missions on Titan Centaurs in 1973. The orbiter will carry the lander into orbit about Mars, select the landing site, and work as a team with the lander to relay data from the lander to the Earth, as well as make scientific measurements similar to the 1971 orbiter.

The Pioneer Program, including the Pioneer F and G missions, is also proceeding as authorized in Fiscal Year 1969. The Pioneer F and G spacecraft will fly through interplanetary space beyond the orbit of Mars, through the asteroidal belt, and to the vicinity of Jupiter. We also have a cooperative project with West Germany under discussion, called Helios, for measurements of the interplanetary medium very close to the Sun.

New projects in the proposed Planetary Program budget are key elements in the balanced approach to planetary exploration. The Planetary Explorer Program will provide the means to obtain environmental information about the nearby planets, Venus and Mars, with a relatively inexpensive small spin-stabilized spacecraft. The 1973 Mariner dual planet mission to Venus and Mercury will be our first mission to Mercury.

I will turn now to the Bioscience Program.

There are three major goals in our Bioscience Program: (1) to understand the role of gravity in life processes, from the level of individual cells up to the level of control over gross physiological systems; (2) to understand the natural rhythms in living systems; and (3) to search for knowledge concerning the origin of life and the distribution of life in the universe. All of these are achievable only through the use of space flight.

The most significant event in the area of Bioscience during Calendar 1968 was the continued analysis of the results of the Biosatellite II mission. Some of the studies gave insights into several mechanisms of plant behavior and growth. It was found that weightlessness altered the posture as well as the growth of plants. Although the causal mechanism is not yet clear, there was evidence that radiation and flight conditions do interact, and when cell nuclei are dividing, radiation-induced damage is increased. Understanding the causal mechanisms of radiation damage may have a major impact on the use of radiation treatments of disease.

The major activity in Calendar 1969 will be the launch of Biosatellite-D, which will carry a thoroughly instrumented monkey. During 30 days in Earth orbit, and after recovery, the physical and mental functions of the monkey will be studied in greater detail and with greater precision than any other physiological investigation in the history of space science.

We had originally planned to conduct a total of six Biosatellite missions; however, late in 1968 we canceled the two 21-day missions. These two missions were canceled because funding constraints had delayed the launch until at least late 1971. Rather than continue to defer the missions because of further funding constraints, the decision was made to cancel the two missions and to plan a new Bioscience program using the experience of the four biosatellite missions and taking full advantage of advancing technology and new experimental techniques.

During Calendar 1969 we plan to study three future options: Use

of an improved recoverable Biosatellite, use of a small Bio-Explorer satellite to conduct experiments which do not require recovery, and conduct of bioscience experiments in manned Earth orbital missions.

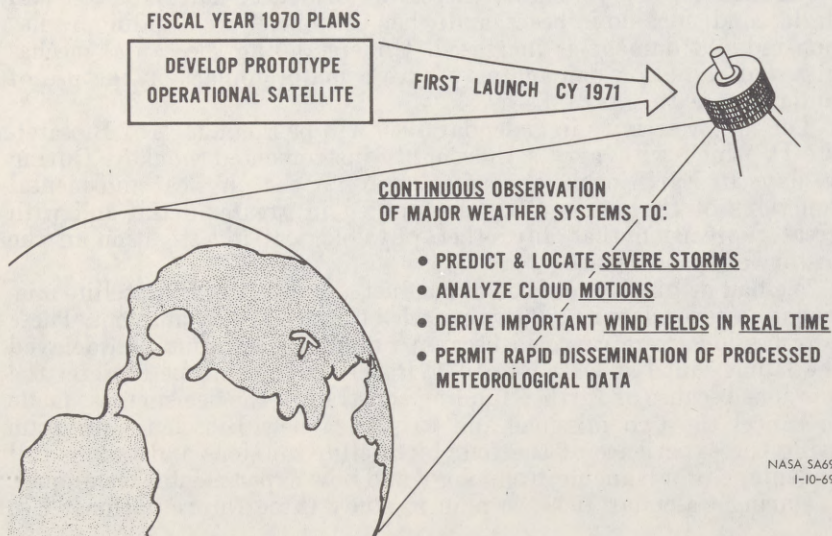
Turning now to the Space Applications Programs, I will address the projects in the context of our objectives for each of the following areas: meteorology, communications and navigation, geodesy, and Earth resources survey.

There are three general goals for the meteorological program. The first is to provide the technology and techniques for obtaining the twice-daily pictures of the global cloud cover which are so important for 1- to 2-day weather predictions. The second goal is to develop infrared and microwave sounding techniques for global measurements of the vertical structure of the atmosphere using satellites. When we have the capability to measure the temperature, pressure, moisture content, and velocity of the air at several altitudes, at many locations over the Earth, meteorologists should be able to generate 1- to 2-week forecasts of major weather conditions.

The third goal is to develop a system for continuous observation of severe storms from synchronous altitude. At this altitude a satellite remains fixed above a particular area of the Earth. The development of the Synchronous Meteorological Satellite (chart SA69-385) will enable meteorologists to continuously monitor cloud patterns associated with short-term but, nevertheless, severe storms, such as thunderstorms and tornadoes; to monitor tropical weather systems, including hurricane development and tracking; and to compute wind velocities by short-term tracking of clouds.

The objectives in the area of communications and navigation are to provide a technological capability to use satellites with increased numbers of smaller and more economical Earth terminals; to use

SYNCHRONOUS METEOROLOGICAL SATELLITE



satellites for the distribution and direct broadcast of television for mass communication; to use satellites for air/sea rescue, navigation, and traffic control; and to use satellites in assisting with data collection from, and for tracking and communicating with, future space vehicles.

In the area of geodesy we have three objectives: to accurately determine the shape of the Earth and tie together the many independently surveyed datums to an accuracy of plus or minus 35 feet; to describe the anomalies in the Earth's gravitational fields; and to apply the technology and techniques of space exploration to the solid Earth sciences and oceanography.

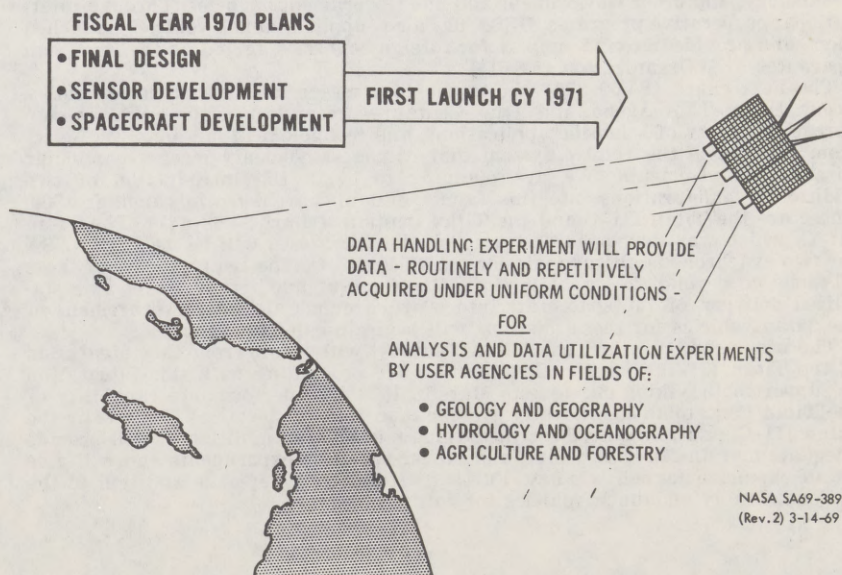
In the Earth resources survey area our objective is to develop techniques for the economic use of satellites to survey the natural and cultural resources of our Earth and to monitor the changes in these resources (chart SA 69-389). The disciplines most directly involved in Earth resources are geology and geography, hydrology and oceanography, and agriculture and forestry.

As mentioned before, the most significant practical application of space technology in Calendar 1968 was the use of ATS-I and ATS-III in the study of severe weather phenomena.

The major flight activity in the Space Applications Program in Calendar 1969 will include the launch of Nimbus B-2, and the launch of the prototype for the second-generation operational meteorological satellite, TIROS-M. In the fall of 1969 we will launch ATS-E with its very important gravity gradient and stabilization experiment, which will make possible a very long lived antenna pointing from synchronous altitude.

Our fiscal year 1970 budget of Space Applications requests authority to develop a prototype operational Synchronous Meteorological

EARTH RESOURCES TECHNOLOGY SATELLITE



Satellite in support of the National Operational Meteorological Satellite Program. Work in support of the basic objectives of the Earth Resources Survey Program has progressed so well that we believe it is now appropriate to request funds to initiate the design and construction of an Earth Resources Technology Satellite (ERTS). We feel that this is an essential step in a logical research and development program.

Based on aircraft investigations, spacecraft data analyses, systems and benefits studies, spacecraft definition, and interagency coordination on requirements, we are clearly ready to proceed with the ERTS Program.

A design study for the first Earth Resources Technology Satellite (ERTS-A) is nearing completion. Advanced sensor development has been initiated, and systems and experimental requirements have been established with the help of the user agencies.

The National Academy of Sciences Summer Study on Space Applications was concluded in 1968. The report of that group has been distributed to you. The Summer Study concluded that the benefits to be obtained from practical space applications appear to be larger than most of the participants in the Study anticipated, and they recommend an energetic program to realize those benefits.

Mr. Chairman, since I am running behind time, I would like to submit the Launch Vehicle Program part of my statement for the record, and go on to the summary on page 23.

Mr. TEAGUE. All right.

(That portion of Dr. Naugle's statement referred to is as follows:)

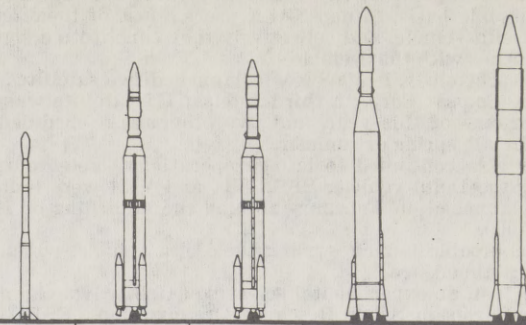
LAUNCH VEHICLE PROGRAM

Launch vehicles provide the means of conveyance in our space program—in essence, they are the transporters of our spacecraft into space. They must do this reliably, accurately, and economically for efficient operation. Our Launch Vehicle and Propulsion Program is responsible for the development and operation of efficient and reliable launch vehicle systems to support the automated flight missions which are being conducted by OSSA, the Office of Advanced Research and Technology, and other Government and non-Government agencies. Through international cooperative programs, OSSA has also supplied launch vehicles, launched them, and provided ground support for foreign countries, including the European Space Research Organization (ESRO).

The next chart (SV69-373) shows the four major launch vehicle systems—Scout, Delta, Thor Agena, and Atlas Centaur—presently used by OSSA in support of a variety of scientific applications, and technological missions. We select from this stable the vehicle system that can most efficiently meet a particular mission's requirements. We are planning to begin the introduction of two additional configurations into this family of launch vehicles in calendar 1969. These are the Titan III-C and the Titan Centaur (chart SV69-481). The Titan III-C, which was developed and used by the Air Force, will be used by NASA for two synchronous altitude missions, ATS F and G. The requirements of these missions go beyond the capability of Atlas Centaur and require three-axis stabilized delivery of the spacecraft into a synchronous altitude. Procurement of the Titan vehicles for these missions will begin in calendar year 1969.

The other configuration, the Titan Centaur, will result from the integration of the Titan III-D with the Centaur. We are proceeding with this integration to support both Viking missions to Mars in 1973. The performance capability of the Titan Centaur is significantly greater than that of the Atlas Centaur or the Titan III-C, and is required for the Viking missions. In addition, it will provide adequate margin for both orbital and lander scientific experiments and will give us an expanded launch window. Further, it will be a versatile addition to the national family of launch vehicles for future missions.

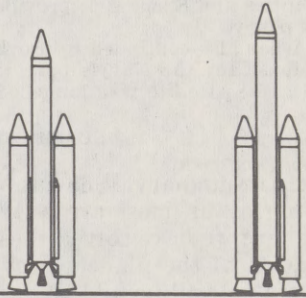
OSSA LAUNCH VEHICLES FOR AUTOMATED SPACECRAFT



VEHICLES	SCOUT	TAT DELTA	TAT AGENA	ATLAS AGENA	ATLAS CENTAUR
• NO. OF STAGES	4	3	2	2	2
• HEIGHT (FT.)	73.5	106.2	109.7	119.0	117.4
• DIAMETER (FT.)	3.4	8.0	8.0	10.0	10.0
• PERFORMANCE - LBS IN 300 N. MI. ORBIT	300	2000	2,500	7,300	9,900
• PERFORMANCE - LBS IN SYNCHRONOUS TRANSFER ORBIT	-	650	-	2,000	4,000

NASA SV69-373
REV. 1-21-69

OSSA LAUNCH VEHICLES FOR ADDITIONAL AUTOMATED SPACECRAFT



VEHICLES	TITAN III C	TITAN/CENTAUR
• NO. OF STAGES	3	4
• HEIGHT (FT.)	127.0	145.0
• DIAMETER (FT.)	10	10
• PERFORMANCE-LBS IN • 300 N. MI. ORBIT	23,000	34,000
• SYNCHRONOUS TRANSFER ORBIT	8,000	14,500
• MARS/VENUS	2,650	7,000

NASA SV69-481
(Rev. 1) 2-5-69

As a matter which is closely related to NASA's launch vehicle program, I would like at this point to say something about the launches NASA provides, on a reimbursable basis, to non-NASA users. Most of them employ a configuration of the Delta vehicle, and collectively they constitute a significant portion of the total launches with that vehicle.

As I noted previously, in 1968 NASA launched two satellites in the Intelsat III series for the Comsat Corp.; a third Intelsat III satellite was launched successfully in February of this year, and two others are scheduled for launching in March, and in late spring or summer.

NASA has also continued to launch operational meteorological satellites for ESSA, using the Delta vehicle. ESSA VII and VIII were launched in 1968; the TOS G was launched on February 26, and the launching of ITOS A is planned for October 1969.

Other reimbursable launches using the Delta vehicle, which have already occurred or are planned, are:

The HEOS A-1, an experimental scientific satellite, was launched in December 1968 for the European Space Research Organization (ESRO). Discussions are now being held for the launching by NASA of the HEOS A-2, in 1971.

Skyнет A, which is an operational communications satellite, will be launched for the Government of the United Kingdom in August 1969. Since this satellite will be operated as part of the Initial Defense Communications Satellite Project (IDCSP) of the Department of Defense, the launching will be furnished by NASA through the U.S. Air Force, but will be paid for by the United Kingdom. A second Skyнет satellite launching has been provided for on an optional basis.

NATO-A, also an operational communications satellite, will be launched for NATO, with a planned launch date in December 1969. This launching will also be furnished by NASA through the U.S. Air Force. Other NATO satellites are planned for launching beyond 1969.

Another potential reimbursable launch for a non-NASA user will be of an operational domestic communications satellite for the Government of Canada, in 1971. Canada is currently discussing its plans for establishing a domestic satellite system with our Department of State. NASA has advised State that it will be prepared to furnish such a launch to Canada, under the authority of the National Aeronautics and Space Act, provided it is determined that this is consistent with U.S. policy.

Finally, NASA has also continued to provide Scout launch vehicles to the Department of Defense for the Navy's operational navigational satellite system, known as Transit. One satellite was launched in 1968, two others are planned in 1969.

SUMMARY

Dr. NAUGLE. In summary, 1968 has been a good year. We have made remarkable progress in most areas. While we have had some major problems, I believe we have solved these expeditiously and effectively.

The exploration of the planets provides the opportunity to obtain exciting answers to century-old questions about the solar system in which we live. This increased knowledge of the solar system and comparative studies of the planets should provide direct benefits by enabling us to better understand the processes that affect and control the Earth and its environment.

We are moving toward a number of important milestones in the Space Applications Program, the most important of which is in the Earth resources survey area, where we are requesting funds for the design and construction of a research satellite, called Earth Resources Technology Satellite (ERTS). We think the ERTS Program will be a very valuable addition to mankind's tools for handling the natural and cultural resources of the world.

With the addition of the Titan III-C and Titan Centaur to our family of launch vehicles and the successful corrective actions taken relative to launch vehicle failures in 1968, we believe that this Nation

can rightfully expect the continuation of the high rate of success that we have enjoyed in previous years.

The OSSA Program which I have just described to you is, in my judgment, a very good program, a very exciting program, and one which makes the best use of this Nation's capability with the resources available.

Mr. TEAGUE. Mr. Truszyński.

Mr. NEWELL. May I just interrupt to read a note that has been given to me. It is that President Nixon has just announced his intention to designate Dr. Thomas O. Paine to be Administrator of NASA, subject to the advice and consent of the Senate. [Applause.]

Mr. TEAGUE. I personally am very pleased.

Mr. NEWELL. May I say we in NASA are, too.

Mr. TEAGUE. Mr. Truszyński.

Mr. TRUSZYŃSKI. I will summarize my longer, detailed statement that I have submitted for the record.

(The detailed statement of Gerald M. Truszyński, Associate Administrator, Office of Tracking and Data Acquisition, will be found in the subcommittee on Advanced Research and Technology hearings.)

(A biographical sketch of Gerald M. Truszyński, Associate Administrator, Office of Tracking and Data Acquisition, is as follows:)

GERALD M. TRUSZYŃSKI

Gerald M. Truszyński is the Associate Administrator for Tracking and Data Acquisition. To support space research activities, he is responsible for planning, developing and directing the use of ground instrumentation systems. These include global tracking networks, data acquisition systems and facilities which provide communication links to spacecraft engaged in NASA's unmanned scientific exploration of near Earth space through to the outer limits of the planets; Communication and Meteorological Satellites; and Manned Space Flight programs. These systems also support the Department of Defense scientific space programs and space programs of commercial and foreign entities. In addition, he also has staff responsibility for automatic data processing management.

Prior to his appointment as Associate Administrator, Mr. Truszyński held the position of Deputy Associate Administrator, Office of Tracking and Data Acquisition, since it was created in 1961. He came to NASA Headquarters from the Flight Research Center, Edwards, Calif., in 1960.

Truszyński joined the National Advisory Committee for Aeronautics and the Langley Aeronautical Laboratory in 1944 where he was concerned with instrument research and development and the early adaptation of precision radar systems to the measurement of high speed rocket trajectories for aerodynamic research purposes.

In 1947, Truszyński transferred to NACA's Flight Research Center as instrumentation project engineer on the X-1 rocket research aircraft..

In 1954, he became Chief of the Instrumentation Division, heading the development and operation of on-board research instrumentation, airborne and ground telemetering, ground radar tracking systems and initial automatic data systems required in the flight research airplane program conducted by NACA.

The research aircraft included the X-1, which made the world's first supersonic flight, and the subsequent series of rocket and high speed research aircraft including the X-15 which is currently conducting hypersonic flight research investigations. He was responsible for the technical design, implementation and operation of the 500-mile X-15 "High Range" tracking and data network extending from Edwards to northeast Nevada..

Born in Jersey City, N.J., in 1921, Truszyński received a B.S. Degree in Electrical Engineering from Rutgers University in 1944.

He is a member of Tau Beta Pi and of the Instrument Society of America.

Mr. Truszyński, his wife, the former Helen Bennett of East Millstone, N.J., and two children live in Chevy Chase, Md.

STATEMENT OF GERALD M. TRUSZYNSKI, ASSOCIATE ADMINISTRATOR FOR TRACKING AND DATA ACQUISITION, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. TRUSZYNSKI. Mr. Chairman and members of the committee, I am pleased for the opportunity to appear before your committee again to report on the activities of the Tracking and Data Acquisition Program and to present our budget requirements for fiscal year 1970.

As you are no doubt aware, the tracking networks played a vital role in support of the recent, letter-perfect flight of Apollo 8. In addition to the all-important acquisition of trajectory and telemetry data, the network stations provided excellent voice communications with the astronauts, and relayed the first television sequences from the vicinity of the moon. The television coverage of Apollo 8, which permitted public participation in the dramatic achievements of this mission, was a result of the significant improvements which have been incorporated over the last few years on the spacecraft and in the networks.

Equally as vital as the complex mission control and communications with manned spacecraft is the similar support provided the other NASA programs. As you know, it is the responsibility of the Office of Tracking and Data Acquisition to provide efficient support for all NASA space flight projects. In addition, support is provided for projects of other U.S. Government agencies, private industry, and other countries engaged in cooperative space research endeavors.

To meet the support requirements levied by such a variety of projects, NASA has established a global network of tracking and data acquisition ground stations, supplemented by instrumentation ships and aircraft. Within this network, three types of facilities are operated to meet the needs of the three basic classes of NASA flight missions. Thus, we have (a) the Satellite Network which supports unmanned scientific and applications satellites; (b) the Manned Space Flight Network which, of course, supports the manned flight program; and (c) the Deep Space Network which supports unmanned lunar and planetary missions.

I think it may be appropriate this year, as NASA enters its second decade, to summarize how these networks have evolved in the relatively short span of 10 years. The evolution of the NASA ground facilities has resulted in an existing tracking and data acquisition capability which provides unequalled support to space flight missions in terms of accuracy, data capacity, communications, and most important, reliability.

SATELLITE NETWORK

The predecessor to our current Space Tracking and Data Acquisition Network (STADAN) was a group of stations called Minitrack, in which the prefix "Mini" applied to the minimum-weight transmitters flown on the first satellite projects. At that time the station locations were geographically constrained by the expected low altitude of the early satellites. For these reasons, the Minitrack stations were located, rather closely spaced in latitude, along the 75th meridian to form a "North-South" fence thus assuring one contact per orbit.

Only a few changes were necessary to the Minitrack Network during the 4 years following Vanguard, 1958 through 1962. Although more

and more satellites were launched, they were small in payload capacity, had limited data transmissions, and had orbits that were usually within the range of the Minitrack Network.

During these first few years, however, as NASA laid plans for its future missions—the Observatory series of satellites and satellites in polar, highly eccentric, and synchronous orbits—it became increasingly apparent that the ground facilities must not only keep pace with the projects but, often, due to leadtimes required for construction, must remain one step ahead.

Support requirements of the Nimbus and the Observatory series of satellites, such as the Orbiting Geophysical Observatory (OGO), and the Orbiting Astronomical Observatory (OAO), required that large antennas be installed at certain stations in the network and imposed stringent requirements for real-time command and control of the spacecraft.

In the early days of the space program, it was sufficient to merely track individual satellites and acquire data on a scheduled basis. With Observatory spacecraft, the network was faced with requirements for acquiring large volumes of high-speed data, interpreting and displaying the data, and sending commands back to the spacecraft—all in real time. By keeping pace with the state of the art in the fields of electronics, communications, and automatic data processing, our network engineers developed new hardware systems that could meet those requirements. Currently, these systems are playing a vital role in support of the very successful OAO project.

Projects having highly eccentric or synchronous orbits such as the Interplanetary Monitoring Probe (IMP) and the Applications Technology Satellite (ATS), led to the design, development and incorporation into the network of the Range and Range Rate System.

New developments such as these have improved the capabilities of the network to such a degree that the support of the most complex satellites, such as OAO, can be accomplished with accuracies and data capacities improved by orders of magnitude over the network capabilities of 10 years ago.

To best appreciate these improvements, it may be well to review the support requirements of the Vanguard Project as compared to the requirements of OAO. Vanguard required only a single command to turn its experiment on or off. The spacecraft's telemetry signal sent a few dozen words to the ground each second. Today, operation of OAO involves issuing and verifying, from the ground, hundreds of command messages, and receiving some 10,000 data words per second. Further, whereas Vanguard was supported singularly, OAO must be supported simultaneously with dozens of other spacecraft.

Manned Space Flight Network. The ground facilities supporting NASA's manned space flight missions have developed quickly, in keeping with the rapid progress of the manned flight program.

The support required by Project Mercury was relatively simple when compared to the complex requirements of Apollo. At the time of Astronaut John Glenn's flight in early 1962, the network consisted of 16 land stations.

The network's support of the Mercury manned flights provided the experience necessary to move quickly and reliably into support of

the two-man, earth-orbital, Gemini program. The addition of digital data processing and digital command equipment increased the flight control capabilities of individual network stations and permitted a reduction in the number of stations. As configured for Gemini, the network consisted of 12 stations, each capable of handling quantities of data and commands equivalent to the capability of the entire Mercury network, and was fully capable of meeting the more complex requirements of the Gemini dual rendezvous missions.

Significant changes have been made in the network to prepare it for support of the Apollo program. In Mercury and Gemini, teams of specialists had to be located at the network stations during mission periods to analyze flight data and issue instructions to the astronauts. This decentralization of control was necessary due to communications limitations. Throughout Mercury and during the early Gemini missions, it was not possible to transmit, in real time, the volume of data required for flight control decisions. Now, however, the complex flight control of Apollo missions requires a centralized control center and a communications network, which includes the use of communications satellites, capable of relaying many channels of data and commands from and to the spacecraft.

Where Mercury and Gemini included only earth-orbital flights, and communications were limited by the horizon and the low altitude to less than 2,000 miles, Apollo requires transmission of large volumes of data, television, and voice through lunar distances. Three stations, equipped with 85-foot antennas, provide trajectory determination data, voice communications, television, and flight control data communications over 240,000 miles of space to support Apollo's lunar operations. Other stations with 30-foot-diameter antennas cover critical flight periods in the earth-orbital and translunar phases of Apollo missions. They are supplemented by instrumentation ships and instrumented aircraft. Thus, for Apollo, the network consists of a total of 14 land stations, four ships, and eight instrumented aircraft, all equipped with the new precision, high fidelity, Unified S-band system.

The Unified S-band system represents the major technological system change in the evolution of the Manned Space Flight Network. It permits the use of one antenna at each station to perform multiple functions of tracking, telemetry, command, and voice and television communications; a significant improvement over the Gemini systems which required a separate antenna and radio system for each function. More importantly, the Unified S-band system accomplishes these functions more reliably and more error-free with a spacecraft at lunar distance than could be accomplished with earth orbital spacecraft by the Gemini network.

The changes for Apollo were a major undertaking, requiring over 3½ years to complete. Leadtimes as long as these clearly illustrate the necessity to continually advance the capability of the network. Countless improvements have been necessary over the past years to provide a network capability which, in addition to providing the reliability mandatory for astronaut safety, permitted millions of Americans to share the adventures of space exploration via live television.

Mr. Chairman, in the interest of time, I would like to submit the next two sections for the record. These sections deal with similar kinds of advances in tracking and data acquisition capabilities.

Mr. TEAGUE. All right.

(Those portions of the summary statement of Gerald M. Truszynski are as follows:)

DEEP SPACE NETWORK

The significant scientific progress NASA has realized in the conduct of its unmanned lunar and planetary programs has dictated major technological advances in the ground systems supporting these programs. For example, within the past 9 years the flight project requirements for distance coverage have increased from tens of thousands of miles to hundreds of millions of miles. Concurrently with the need to increase distance coverage there have been many other requirements, such as order of magnitude increases in data transmitted, transmission of real-time television, and continuous, highly reliable command and control of the spacecraft.

In 1958, The Deep Space Network consisted of a single 85-foot-diameter antenna station located at Goldstone, Calif. Designed and constructed to support the early Pioneer spacecraft, the facility had little difficulty in meeting the nominal requirements of the project.

With the addition of the new projects, such as Mariner and Ranger, came the need to expand the geographical coverage of the network. Additional 85-foot antenna stations were added, spaced approximately 120° apart in longitude to allow continuous coverage and control of the spacecraft. Once the geographical requirements were satisfied, efforts were devoted to increasing the data rate capability of the ground systems. Data rate refers to the amount of information which can be transmitted to or received from the spacecraft. The distance over which the data must travel is, of course, a major factor in determining the data rate.

An illustrative example of our efforts to achieve higher data rates was the conversion from a relatively low operating frequency, L-band, to a higher frequency, the S-band. Because of engineering foresight during the design of the 85-foot antenna, it was possible to make the frequency conversion and also retain the basic configuration of the antenna. Through the addition of very specialized feeds on the antenna, coupled with the noted frequency change, we were able to increase the distance range of an 85-foot antenna from about 9 million miles to over 70 million miles. This represents, however, about the limit of the distance to which the 85-foot antennas can be used for spacecraft having Pioneer-type telecommunications systems.

Anticipating the need for still further increases in data rate capability, a 210-foot-diameter antenna was added to the network in April 1966. Representing perhaps the single most important advance made to date in tracking and data acquisition capability, the antenna is the world's largest built for support of research by spacecraft. The capability provided by the 210-foot antenna allows spacecraft support at distances up to three times greater than from 85-foot antennas, and, at an equal distance, allows a tenfold increase in data rate.

COMMUNICATIONS AND ADP

While we have noted some of the major changes that have taken place with respect to the evolution of the networks, the story would not be complete without some mention of the attendant advances made in the fields of communications and automatic data processing (ADP).

Spacecraft of the Vanguard vintage required relatively simple communications support since the spacecraft had little, if any, capability for control from the ground. Advances in spacecraft technology, however, quickly brought along requirements for many communications functions to be performed on the ground in real time. The trend towards centralized command control by the flight projects resulted in a requirement for a much higher volume of real-time information to be transmitted through the ground communications system.

Even more demanding was the degree of reliability that was needed under the centralized control concept. The continuing requirements to improve communications reliability, in conjunction with economic considerations, resulted in a consolidation of all operational long line communications into a single system which was designated NASCOM.

An integral part of NASCOM planning was the concept of a primary switching center where circuit-sharing and flexibility with centralized facilities control

could be attained. Through such consolidation, the total NASCOM communications resources are available for use on any mission and, consequently, alternate channels are available in the event of isolated circuit malfunctions.

A major advance in NASCOM communications capability came with the introduction of communications satellite service in January 1967 to meet the reliability requirements of Apollo. As evidenced during the support of the recent Apollo missions, the satellite services have been excellent. Anyone who remembers the voice transmissions of the first Mercury flights would certainly acknowledge a tremendous improvement in communications capability.

The degree to which our networks have evolved in the past 10 years has been possible only through the availability and extensive use of automatic data processing (ADP) equipment. Moving from computing the orbit of Vanguard for post-flight data analysis purposes to the real-time control of a Surveyor spacecraft has forced rapid improvements in the ADP field.

Our requirements for reliable real-time control systems have, of course, had a marked effect upon the computer industry. For the Gemini Program it was necessary to provide a capability for the ground-based computer to communicate with the space capsule with no intervening delays. To meet this requirement, as well as similar requirements from the unmanned space flight projects, industry developed specialized channel equipment which joined the communications terminals directly to the computer thereby permitting real-time entry of high-speed data directly into the computer. This capability made it possible not only to accept the data but also to perform calculations on these data and send information back to the spacecraft in time to be useful.

NASA also pioneered in the application of computers for communications processing. To enable the NASCOM system to relay the volume of real-time data required for mission control, it became essential to provide computer controlled switching in the network. Our establishment of a large, high-speed, real-time communications network has contributed substantially to the state of the art which exists today in communications-oriented computing systems.

Currently, other Government, educational, and commercial organizations are using similar systems to assist them. Applications include medical diagnostic analyses and airline and hotel reservations systems.

PRESENT NETWORK CAPABILITY

Mr. TRUSZYNSKI. The network improvements that have taken place over the past 10 years have resulted in a present-day capability that is unique in its capacity to handle the great variety of space flight missions currently being supported and planned.

Our physical facilities have a capital value in excess of three-quarters of a billion dollars, and include instrumentation ships and aircraft, and some 26 tracking stations located in 15 countries, including the United States. These worldwide facilities provide the ground support for the wide variety of NASA missions, and are currently supporting programs ranging from near-earth sounding rockets to deep space probes hundreds of millions of miles from earth.

The network stations, ships, and aircraft are linked to each other and to control centers by a single integrated NASA Communications System (NASCOM). This interlinking of facilities provides the means for cross-support between the network stations thereby increasing flexibility and, at the same time, reducing the total number of facilities required.

The advantages of developing the network capability which exists today are perhaps most visible when one looks at the flexibility the network provides to the individual space flight projects. For example, flight missions are no longer constrained to restrictive orbits because of limited geographical network coverage, but, instead, may be planned for the type of orbit best suited for the particular scientific investigation. Previous distance limitations have been greatly reduced, and the

network can currently support missions traveling out to the Sun and near planets. Upon completion of the 210-foot subnetwork, this capability will be extended to provide coverage to such distant planets as Jupiter.

Long range programs can rely on the network capability of simultaneous coverage to several missions. Utilization of the capability is perhaps best illustrated by the present flight support provided to the four Pioneer spacecraft traveling in different radial positions from the earth within the solar system. The ability to correlate data acquired simultaneously from the several, widely dispersed spacecraft has greatly expanded man's understanding of our solar system.

Perhaps the most important capability the network provides to project personnel is that of real-time command and control during a mission. Any space flight mission, regardless of the excellence of design, construction, and testing, carries some degree of risk as to malfunction or failure. Partly, this risk arises from the fact that we are exploring a new environment in which only limited knowledge exists. The network is a compensating factor to the risk in that it provides a means to continuously monitor a flight mission, detect any anomalies, analyze the data for the cause of the anomaly, and issue corrective commands to the spacecraft, or, in the case of manned flights, to the astronauts. The continuous monitoring coverage during critical flight phases, together with a real-time command and control capability, was a determining factor in saving a number of important and expensive missions which otherwise might have been unsuccessful, such as Lunar Orbiter I, Surveyor V, OGO IV, and Apollo 5. This continuous monitoring capability, particularly with respect to deep space missions, has contributed significantly to the high success ratio of U.S. flights.

Because such ground capabilities do exist, and through experience have proven to be extremely reliable, it has been possible for NASA to design spacecraft and plan mission profiles in such a manner as to insure maximum data return per project dollar.

DIRECTIONS FOR THE FUTURE

Having noted some of the major steps in the network's evolution and summarizing its present capabilities, I would like to take a few moments to explain the philosophy we have used in building up this capability and why we must continue to improve the network both in its technical capability and its operational efficiency.

In our overall planning to provide support for 11 NASA space flight projects, it is necessary that we consider the total support requirements of all flight projects, both on-going and future, and provide a total integrated capability that is responsive to this overall mix of flight projects.

Experience has demonstrated that only through constant improvement of the ground systems can we possibly keep up with the increasing demands placed upon the tracking and data acquisition resources. An example of our current efforts in such improvements is the completion of a subnetwork of 210-foot antennas. As you know, we have initiated procurement action for the construction of two 210-foot antennas which are planned to be located in Australia and Spain. When com-

pleted and operational in 1973, the antennas, together with the existing 210-foot antenna at Goldstone, will meet the support requirements of the Viking, Pioneer F and G, Helios, and the planned Mariner and Explorer planetary missions.

Due to the fact that since April 1966 we have had an operational 210-foot antenna at Goldstone, we do not anticipate any difficulty in providing two additional 210-foot antennas. If, however, we had not kept pace with, and occasionally pushed, the state of the art in the mid-1960's the Goldstone antenna would still be in the design phase. Further, without the Goldstone experience it is unlikely that the network could develop, in the time required, the capabilities needed to support the aforementioned missions, and NASA might have had to pass up the 1973 Mars opportunity.

The increased tracking and data acquisition capability afforded by the Goldstone 210-foot antenna is also contributing significantly to current missions, in particular the initial planned Apollo lunar landing missions which may well require this added receiving capability to insure a safe margin of signal return for live television reception with the early spacecraft antenna systems to be deployed.

Pioneer is another example of a program which has benefited greatly from the Goldstone antenna. The currently aloft Pioneers VI through IX were designed to accomplish primary mission objectives during the first 6 months of flight into interplanetary space. The increased sensitivity of the 210-foot station made possible the continued reception of scientific data for several years for each of these flights. In addition, it made feasible experiments never conceived in the formulation of the project such as solar and planetary occultations of the spacecraft as viewed from the earth.

Even with the capability which will be provided by the 210-foot antenna subnetwork, it is obvious, based upon past experience, that we must continue to increase the ground capability for support of future missions. The most demanding requirements we foresee in the near future will result from the next phase of planetary exploration.

Missions currently being considered for launch during the mid- and late-1970's will require ground improvements similar to those which have taken place during the past 10 years. Some of these missions will be flown to the furthestmost planets in our solar system and will require reliable, real-time communications over distances reaching billions of miles. In addition to the distance requirements, the network will need to provide more precise ground navigation performance when the spacecraft orbit, and perhaps land, on the distant planets. More advanced data processing systems will be needed to handle multiple orbiting spacecraft acquiring large quantities of visual imaging and science data. These are but a few of the requirements that we see facing the networks of tomorrow. If, however, we are able to maintain our continuing improvement program, they also are requirements that I am confident the networks will meet.

FISCAL YEAR 1970 PROGRAM

During fiscal year 1970, the primary emphasis of the Tracking and Data Acquisition Program will continue to be focused on operational activities. The new space flight missions scheduled for launch in fiscal

year 1970, together with the still active spacecraft launched in previous years, will require that the majority of the requested resources be applied to the operation and maintenance of the network facilities. The workloads of each of the three major networks, the Satellite Network, the Manned Space Flight Network, and the Deep Space Network, will increase in fiscal year 1970 as compared to fiscal year 1969.

To carry out our planned activities in fiscal year 1970, a total of \$298 million is required from the Research and Development appropriation and \$17 million is needed from the Construction of Facilities appropriation to complete the 210-foot antennas.

Of the \$298 million for Research and Development, \$239.4 million or 80 percent is required for the operation and maintenance of the network facilities and for associated services such as data processing and communications. Over two-thirds of the total increase in our budget requirements from fiscal year 1969 to fiscal year 1970 is for Network Operations. The dollar increase of about \$12.5 million is a percentage increase of $5\frac{1}{2}$ percent, which approximates the labor cost increases projected for this time period by the aerospace industry. Considering that the increase must also provide for annualization costs of efforts only partially funded during fiscal year 1969, such as the second shift of operating personnel for Apollo support, it is apparent that we intend to hold the line on operational costs in fiscal year 1970.

Also included in the Research and Development budget request is an amount of \$12.5 million or 4 percent to continue our Supporting Research and Technology (SRT) program. This is the activity which provides for the development of tracking and data acquisition systems for use in the networks to meet the support requirements of future flight projects.

Within the \$46.1 million requested for Network Equipment, \$29.2 million or 10 percent of the total R. & D. request is needed for equipment to sustain the existing network capability. This includes funds for equipment replacement, test equipment, and spare parts at the module level.

Also included in the Equipment request is \$12.8 million or $4\frac{1}{2}$ percent to provide the network capabilities needed to meet the support requirements of future flight projects. These improvements include the modification of selected STADAN stations for support of the Earth Resources Technology Satellite (ERTS), and an increase in the data handling capabilities of the Manned Space Flight Network for the Apollo Applications Program, and of the Deep Space Network for the Mariner '71 Mars mission.

We have included sufficient funds in the Equipment budget to sustain the present network capability and provide for the equipment needed to meet unique requirements of NASA's new flight projects. For the second consecutive year, however, we could accommodate, within the total program, only a small percentage for network improvements. This dollar amount of \$4.1 million represents only $1\frac{1}{2}$ percent of the total fiscal year 1970 budget request, and less than 1 percent of the amount NASA has invested in tracking and acquisition facilities over the past 10 years. This amount represents also, in our opinion, the very minimum that should be allocated to this area.

I want to stress the fact that it was this area, network improvements, that accounted for much of the rapid evolution in the Tracking and Data Acquisition networks which I described earlier. It is unfortunate that such an important item in our program is the area most susceptible to budget reductions. Because of the operational support requirements we must meet, virtually the entire remainder of our budget must be considered generally fixed cost, and, consequently, any reduction to our budget request must be absorbed in the improvement items. The amount budgeted in fiscal year 1970 will permit us to implement some improvements planned in fiscal year 1969 but deferred due to budget reductions. With any amount less than our request, the network capability will undoubtedly fall behind the state-of-the-art and, quite possibly, become a limiting factor in planning future space flight missions.

CONCLUDING REMARKS

Mr. Chairman and members of the committee, I have described some of the major changes that have taken place in the tracking networks during the past decade and briefly outlined the changes that will be necessary in the future. These will be discussed in more detail, of course, during our appearance before the subcommittee.

I sincerely hope that we have adequately conveyed the necessity for continuing to improve the capability of the NASA tracking networks—a capability which today is second to none. We now request your continued support of the Tracking and Data Acquisition Program and favorable consideration of our budget request.

In closing, I would like to express my appreciation for this opportunity to appear before the committee. It is most gratifying to be able to report once again that the NASA networks during the past year met the support requirements of all flight projects on schedule and with excellent reliability.

Mr. Chairman, this concludes my statement.

Mr. TEAGUE. Are there any questions from the members of the Committee. Mr. Wydler.

Mr. WYDLER. Thank you, Mr. Chairman. I just want to ask Mr. Finger whether this change in the name of Administrative Operations is an attempt to change the actual nature of the duties, or the things being done under the old title of Administrative Operations, or to make it more amenable to increased budgetary amounts?

Mr. FINGER. Congressman Wydler, it is not a change in substance of the budget. We felt for a long time that Administrative Operations didn't describe the content of this part of our budget, because so much of this is nonadministrative. It provides for support of our technical competence and the management of our programs. The important thing is that the budget does pay for all of our technical people, who do the in-house research and manage our outside contract activities, and we have felt for some time there was some misunderstanding of the nature of that budget; that misunderstanding, we felt, was partially generated or contributed to by the title of Administrative Operations.

The committee has strongly supported us in recognizing what that budget contains. As an example, last year both the House and Senate

Authorization Committees recommended authorization of larger amounts than those later authorized by the Congress. We indicated then in hearings before the Senate that we were considering a change in the name, and did go ahead then on that basis to try to develop a name which is really descriptive of the nature of the work and functions covered by that budget.

Mr. WYDLER. Outside of the change of the name, is there anything else that has been changed in regard to that program?

Mr. FINGER. No, sir.

Mr. WYDLER. Can we consider that is still the same old administrative operation?

Mr. FINGER. I would hope you wouldn't consider it the same old Administrative Operations, but recognize the importance of it. Without that budget, or with further cuts, we can't do the program activities we have. The whole management method we have set up relies on the in-house technical and management strength supported by the funding in that budget, and it is essential to the success we have had.

But there is no change in the substance of it. The AO categories, the categories listed last year, are exactly retained in the Research and Program Management Budget line items this year.

Mr. WYDLER. I understand you can't run a program without people?

Mr. FINGER. I realize that.

Mr. WYDLER. But what I am interested in here is the level that has been maintained. How it has changed, between the Civil Service grants at NASA and the contract personnel. Can you relate in some meaningful way, percentage-wise, the numbers between last year or this year, or for the last 2 years?

Mr. FINGER. Let us look at the total manpower employed in the space program. I am sure you are familiar with the figures that indicate that our total has come down from about a maximum of 420,000 people to 215,000 by the end of this year, and that overall manpower will continue to decrease to about 190,000 by July 1970. Our civil service manpower has dropped by a number that is equivalent to 3591 from its maximum, or something over 10 percent of our total. The important point is that we never staffed up to the full levels we would have needed because we turned to the use of in-house support contractors where it was appropriate. In that way, as the program built up, we stayed at a fairly uniform level of civil service manpower throughout NASA. That level would have had to be increased by a factor of two if we kept the same ratio of industry to civil service employees throughout the years. We are now back to the same ratio levels we had in 1962.

Mr. WYDLER. I don't think I understand the comparative percentage.

Mr. FINGER. The total manpower is down to less than half of what it was. The in-house civil service manpower is down by about 10 to 12 percent. The in-house support contractor manpower is down also. I don't have the exact percentage of that decrease, but I can get that.

Mr. WYDLER. I would like to see it. I would like to see the percentage numbers for the last 3 fiscal years, and for this projected budget, of course.

(Information requested is as follows:)

PERCENTAGES OF REDUCTION FROM MAXIMUM EMPLOYMENT LEVELS FOR CONTRACTOR PERSONNEL

	Contractor employment	Reduction from maximum	
		Number	Percent
February 1966 (maximum employment).....	387,000		
Fiscal year 1967.....	273,200	113,800	29.4
Fiscal year 1968.....	235,400	151,600	39.2
Fiscal year 1969.....	186,600	200,400	51.8
Fiscal year 1970.....	157,000	230,000	59.4

NASA SUPPORT SERVICES CONTRACTS,¹ MAN-YEARS OF EFFORT, FISCAL YEARS 1966-69

	1966	1967	1968	1969 (estimated)
Ames Research Center.....	186	196	364	388
Electronics Research Center.....	218	28	75	135
Flight Research Center.....	218	288	495	426
Goddard Space Flight Center.....	3,996	6,077	6,933	6,911
Headquarters.....	433	843	718	786
Kennedy Space Center.....	5,931	7,628	8,633	9,703
Langley Research Center.....	517	635	775	729
Lewis Research Center.....	270	287	309	303
Manned Spacecraft Center.....	3,812	5,970	6,328	7,595
Marshall Space Flight Center.....	6,822	6,291	6,017	4,646
Wallops Station.....	191	189	190	203
Total.....	22,385	28,432	31,437	31,825

¹ Contracts of \$100,000 and over.

Mr. FINGER. The figures we have for support contractors show some increase right up to last year. It was really this year and toward the end of last year they began to level off overall, and to show decreases in several Centers. At the Marshall Space Flight Center between FY 1966 and 1968 there has been a reduction of 805 man-years, with an additional reduction of 1,371 man-years planned for FY 1969. At the Goddard Space Flight Center, we are reducing 559 positions in FY 1969 by conversion, with an additional 251 programmed for FY 1970.

We are now in a peak period of inhouse activity at the Manned Spacecraft Center and Kennedy Space Center, as the Apollo hardware previously developed by the prime contractors comes to our Centers for verification, checkout, and launch. In these Centers the support contractor activity has also increased to meet the program demands, with these increases offsetting reductions made elsewhere.

You might say, we do not have a handle on the exact numbers of support contract personnel applied because we are not generally controlling those contracts by the exact numbers of people on those contracts. We give them a function to do and expect they will then provide enough manpower to do that job. We have been trying to collect those data, and I would say our data there are not quite as accurate as our own Civil Service manpower data.

Mr. WYDLER. I am sure when you give somebody a contract you have some idea of how many people will be involved.

Mr. FINGER. We limit the total effort to a ceiling of man-years, but the contractor must manage to stay as much below that as he can but still be assured he can get the work done.

Mr. WYDLER. One last question, and I think it is your department.

I was reading in the newspaper today about some type of demonstration—I don't know if I should call it a demonstration, but an activity on the campus of MIT. I don't know where else it might have taken place, but it had something to do with an objection to the type of research going on on the campus. Now, not commenting on the sense of such a demonstration, but I would like to ask, does that affect the NASA operations at MIT, or the Electric Research Center, or any of our other operations of NASA?

Mr. FINGER. Not so far as I know, but I am not sure enough of it. Perhaps Frank Smith knows a little more. Do you want to answer, Frank?

Mr. SMITH. I think the impact of this, if any, would be minor, Mr. Wydler. As I understand the work stoppage, the people involved deal mostly with DOD contracts. They are taking 1 day off to discuss the political, social and economic aspects of DOD research.

Mr. WYDLER. Do you know if that 1 day off was with pay?

Mr. SMITH. In my view, those involved could not collect Government pay for that day.

Mr. WYDLER. Thank you.

Mr. TEAGUE. Mr. Pelly.

Mr. PELLY. I would like to ask Mr. Finger if any of the scholarships that NASA has given have resulted in disqualifications due to campus disorders? We have a provision in the law, as I recall, which would disallow any such trainees or scholars under our funds to participate in any college disorders.

Mr. FINGER. That is correct. We have had no disqualifications on that account.

Mr. PELLY. I think you did a good job then in selecting your candidates.

Mr. FINGER. I should mention that under our training grants, we provide funds to the university, and the university makes the selection of students under those grants. The amendment contained within our law in effect precludes us from providing funds to universities that restrict Armed Forces recruiters. None of our grants, therefore, have been given to universities that restrict Armed Forces recruiters. So we have not run into that problem.

Mr. PELLY. How about the reduction from 50 to 20 universities that are on your research list. That is a very substantial cut. What is that in terms of dollars?

Mr. SMITH. The reduction is just about 50 percent, from 50 to 30. In FY 1967 we had about \$11 million in the research portion of the supplementary budget; this year it is down to about \$5 million.

Mr. PELLY. Is any of that research work taken up in Centers.

Mr. SMITH. No, not directly.

Mr. PELLY. Not by the Electronic Center or—

Mr. SMITH. Not directly.

Mr. FINGER. I might add, that although this is a reduction of 50 down to 30 this year, we have stepfunded these grants to provide stability. If the funds are cut off, the university can phase out of the activity over a 3-year period. With a process of stepfunding, and those 50 had been stepfunded. We are not providing new money to 20 of those; we are giving that new money to only 30 universities. But

all of the original 50 are therefore, I think, still in the program due to the stepfunding. The phasedown will be gradual.

Mr. TEAGUE. Are there any more questions? Mr. Winn.

Mr. WINN. I have no questions, but I have a short statement. These hearings are extremely encouraging to me, Mr. Chairman, because earlier Dr. Naugle pointed out the OSSA Program, and showed a slide illustrating that the country was going to get more advanced information on tornadoes and tracking of tornadoes. This certainly is important to a large part of the country, and this is most encouraging.

Along that same line Dr. Naugle mentioned the important milestones in the space applications program. He says we think the ERTS program will be a very valuable addition to mankind's tools for handling the natural and cultural resources of the world. This is what I was trying to say yesterday in the hearings, that this is very encouraging, and I am pleased we are going in this direction. I had been a little discouraged in the way we had been going.

Mr. PETTIS. Along that same line, Mr. Chairman, I would like to ask a question based upon some testimony we received here from, I believe, representatives of the Interior Department, some weeks back, in which they placed approximate dollar values on some of the work they were doing in terms of putting money back into the treasury on the basis of leases and so on. Do you think it will be ever possible for us to do that with this committee, or with this Agency? We are now talking about space technology, and applying technology to industry and so on. Now, this has dollar values and job values. How soon will it be before we can put some dollar values and people values on these programs that apply to new technology and industry?

Dr. NEWELL. Mr. Pettis, we are conducting a number of studies in this area in order to do just what you are inquiring about. In order to move ahead in the earth resources area in a sensible way we have to know what are the best approaches to handle some of these observations, whether by a ground based, aircraft borne, or satellite borne approach, and where the returns will come, and where the potential users are. In order to have that background information we have a number of contracted studies going on at this very moment.

I would say in the years immediately ahead they will have a pretty good estimate of the kinds of returns we are getting.

Mr. PETTIS. I think it would be encouraging to the public, and particularly members of this committee. I am asked this by Members of Congress who know I am on the committee, and I am not able to answer very directly.

I am very encouraged by the testimony this mornnig, even though it is general, and I would hope we place some specific value on it.

Mr. TEAGUE. I have a number of questions, but in view of the limited time remaining I will ask that you submit the answers for the record. Now I understand that you have a film to show us.

(The film was shown.)

Mr. TEAGUE. The committee will be adjourned.

(Whereupon, at 11:50 a.m., the committee adjourned.)

(Information requested is as follows:)

CONSTRUCTION OF FACILITIES

Since the beginning of the NASA program, there have been over \$2.6 billion authorized for construction of facilities and almost \$2.5 billion appropriated for these purposes excluding transfers between appropriations.

Question. To what extent has the annual Section 3 transfer authority been used since the program began?

Answer. Since the program began, NASA has transferred \$168,660,-850 from R. & D. to CoF against the annual Section 3 transfer authority which totals \$371,859,720 as follows:

CONSTRUCTION OF FACILITIES—R. & D. TO CONSTRUCTION OF FACILITIES TRANSFER ONLY

	Sec. 3 authority	Amount used
1962.....	\$38,775,000	\$33,972,500
1963.....	86,936,340	82,952,950
1964.....	78,520,000	42,350,300
1965.....	87,271,880	8,444,800
1966.....	22,655,000	940,300
1967.....	21,225,000	
1968.....	19,625,000	
1969.....	16,851,500	
Total.....	371,859,720	168,660,850

The flexibility granted NASA by Section 3 of the proposed Authorization bill and past authorization acts has been indispensable in accelerating our construction program to eliminate delays in the research and development for lack of facilities. Through the use of the flexibility contained in the authorization acts, NASA in the past was able to start facility construction which could not be deferred until the enactment of the next authorization act. These unexpected construction needs arose from changes in research and development establishing new or revised R. & D. programs, new R. & D. scientific and engineering developments and the acceleration of approved R. & D. programs.

Because of the greater stability that has been achieved in recent years, we have made relatively few program changes involving facilities and therefore have not needed to use the flexibility available. However the existence of authority, which is available to be used as it is required, gives NASA the capability of taking prompt action to provide facility construction for new or changed research and development requirements.

Question. Of the \$2.5 billion appropriated plus those funds transferred into the construction of facilities appropriations, how much has been obligated?

Question. How much of the \$35.7 million included in the fiscal year 1969 funding plan has been obligated?

Answer. Including fiscal year 1969 there has been appropriated to or transferred into the Construction of Facilities appropriation a total of \$2,637.2 million. Of this total \$2,573.5 million has been obligated through February 1969. This leaves an unobligated balance of \$63.7 million as of February 28, 1969.

Answer. Through February 1969 a total of \$19.9 million has been obligated against the \$35.4 million now in the fiscal year 1969 Construction of Facilities operating plan. This leaves an unobligated balance of \$15.7 million as of February 28, 1969.

Question. When does NASA plan to obligate the balance of appropriations available for construction purposes?

Answer. Of the total of \$63.7 million Construction of Facilities funds unobligated as of February 28, 1969 it is presently estimated that about two-thirds will be obligated prior to June 30, 1969 and the remaining one-third will be essentially all obligated during the first quarter of FY 1970.

Question. How much of the authorization for construction of facilities has expired as a result of the automatic rescission provision since the program began?

Answer. Since the beginning of the NASA Program, \$89,669,000 of the authorization to appropriate for construction of facilities has expired as a result of automatic rescission provisions.

Question. According to a special analysis included in the backup books the capitalized value of NASA's facilities, including contractor-held facilities, was \$4,412,274,000 as of June 30, 1968. How much of this amount represents facilities transferred from NACA?

Question. From DOD?

Question. From other Federal departments and agencies?

Question. What was the source of funds for the balance of facilities other than those authorized under the Construction of Facilities appropriation?

Answer. As the question points out, the reported capitalized value of NASA facilities on June 30, 1968, was \$4.4 billion. This "value" is of course carried at "initial acquisition" cost to the Government and does not reflect current replacement value. In addition, it should be recognized that the \$4.4 billion is a "net" figure which takes into consideration disposals as well as acquisitions.

The "value" of the facilities transferred from NACA to NASA is approximately \$350 million.

Our physical and financial property records are not designed to break out the "value" of capital type property acquired by transfer from individual Government agencies. However, in searching other available records we have been able to identify the major acquisitions

which have occurred since NASA was organized. Facilities valued at \$296 million have been acquired from the DOD by direct transfer. We estimate that facilities valued at something less than \$10 million have been acquired from agencies other than NACA or DOD but we have no way of precisely identifying this amount. It is also estimated that additional facilities items (i.e. equipment only) valued at another \$210 million has been acquired by transfer to NASA of property excess to other Government agencies including DOD.

The source of funds for the balance of facilities (real property and personal property of a capitalized nature) not realized from the Construction of Facilities account, were Administrative Operations, Research and Development, or their predecessor accounts. The bulk of this balance is made up of equipment acquisitions, particularly through the R. & D. appropriation.

Question. Based on presently assigned missions how much will it cost to complete all identified facilities requirements?

Answer. A significant portion of the NASA physical plant is represented by older facilities which originated with NACA or, as in the case of the industrial plant, was transferred to NASA from the DOD. A continued program of modifications and rehabilitation is required to protect this investment and to enhance its capabilities. For this purpose, prudently at least \$15-20 million and perhaps more realistically \$20-30 million per year can be applied to this phase of the NASA facilities program.

Aside from programmatic, unique, or exceptional very-high-cost needs, there remains the task of correcting facilities shortages associated with general institutional support at most NASA field installations. Involved here is the need for additional space for the administrative and technical work force, additional general laboratory space, new research and development facilities having a broad application, more shop and storage space, and enhanced utility support. NASA must be increasingly concerned with the possible obsolescence of portions of its physical plant. It is estimated that some \$50-70 million per year could wisely be devoted to meeting these compelling needs.

Over and above any new but currently unidentified or exceptionally large programs which may be assigned NASA, there will be the need to meet recurrent programmatic needs. These cannot in all cases be identified in advance, but for planning purposes we can conservatively estimate some \$30-50 million per year will be required to meet these needs.

In summary, therefore, setting aside the requirements of any large new programs, it is estimated that NASA facility needs can be reason-

ably estimated to be at a level of \$100-150 million per year over the next several years. The actual Construction of Facilities budget levels in future years will depend upon such factors as guidelines received and demands on agency resources.

Question. What is the annual cost of maintaining installation master plans?

Answer. It is our estimate that \$150,000 to \$200,000 will be required each year to update, on schedule, the master plans of NASA field installations.

Question. How often are they updated?

Answer. NASA now plans to update the master plans of its field installation every three years accomplishing the work at about one-third of the installations each year. Over a 3-year cycle a total of \$500,000 to \$600,000 will then be required for this purpose.

Question. How many personnel are presently assigned to facilities management activities in the NASA headquarters?

Question. Are they centralized in one office or assigned to program offices?

Answer. A total of 40 personnel (including clerical) are so assigned.

Answer. In 1968 the Office of Facilities was created within NASA headquarters to centralize all facilities functions and to serve the program offices as well as the remainder of the headquarters. The Office of Facilities is fundamentally responsible for establishing key facilities management and operational practices and to review and monitor facilities operations at all levels. Some of the more specific areas of activity include advice, guidance, and support to Program Directors, Institutional Directors, and senior NASA Management in all facilities matters. The Office is also responsible for direction, technical guidance, and surveillance over such diverse facilities related areas as design, engineering, master planning, real estate, plant maintenance, and operations, and all programs for repair, alteration, minor and major construction. All of the 40 personnel mentioned above are assigned to that office.

Question. On an agency-wide basis, how much is NASA paying for off-site leasing of facilities due basically to a shortage of on-site facilities?

Question. Has any planning been done with a view toward providing adequate on-site facilities thereby eliminating the need for continued off-site leasing?

Answer. At the present time NASA is paying about \$1.6 million per year for off-site leasing (including utilities and related services) due basically to a shortage of on-site facilities.

Answer. Yes, this is a matter of continuing concern with NASA at all levels. In view, however, of possible programmatic and other variables, it may not be prudent at a given field installation to provide on-site facilities for all personnel and especially not for all support contractor personnel. Each installation is evaluated on its particular merits including the long-range potential of the need.

Question. There is included in the fiscal year 1970 authorization request a project under "Various Locations" in the amount of \$9 million to provide for major improvements, rehabilitation and alteration of government-owned facilities. Please provide for the record a complete list of individual projects to be accomplished by center indicating the project title and dollar amount.

Answer. The attached list by NASA field installations covers a total of some \$13 million of separate projects which forms the basis for our \$9 million request. The listing also indicates those projects which would now be accomplished from this \$9 million. If, and as circumstances change, it is manifest that priorities must be adjusted accordingly.

MODIFICATIONS AND REHABILITATION SUMMARY

	Modifications	Rehabilitation	Total
1. Office of Manned Space Flight.....	\$4,650,000	\$3,247,000	\$7,897,000
a. Kennedy Space Center.....	2,100,000	2,762,000	4,862,000
b. Marshall Space Flight Center.....	1,025,000	75,000	1,100,000
(1) Marshall Space Flight Center, Huntsville.....	(500,000)	(.....)	(500,000)
(2) Michoud Assembly Facility.....	(300,000)	(.....)	(300,000)
(3) Mississippi Test Facility.....	(225,000)	(75,000)	(300,000)
c. Manned Spacecraft Center.....	600,000	410,000	1,010,000
(1) Manned Spacecraft Center, Houston.....	(100,000)	(100,000)	(200,000)
(2) Ellington Air Force Base.....	(500,000)	(310,000)	(810,000)
d. Various locations.....	925,000	.....	925,000
(1) Marshall Space Flight Center locations:	.....	.....	.....
(a) Edwards Air Force Base.....	(120,000)	.....	(120,000)
(b) Seal Beach.....	(160,000)	.....	(160,000)
(c) Canoga Park Air Force plant No. 56.....	(185,000)	.....	(185,000)
(d) Santa Susana Air Force plant No. 57.....	(160,000)	.....	(160,000)
(2) Manned Spacecraft Center locations: (a) Downey industrial plant.....	(300,000)	.....	(300,000)
2. Office of Advanced Research and Technology.....	2,100,000	810,000	2,910,000
a. Ames Research Center.....	482,000	75,000	557,000
b. Langley Research Center.....	725,000	685,000	1,410,000
c. Lewis Research Center.....	640,000	25,000	665,000
d. Plum Brook Station.....	253,000	25,000	278,000
3. Office of Space Science and Applications.....	2,250,000	.....	2,250,000
a. Goddard Space Flight Center.....	750,000	.....	750,000
b. Jet Propulsion Laboratory.....	750,000	.....	750,000
c. Wallops Station.....	250,000	.....	250,000
d. Unmanned launch operations, KSC.....	500,000	.....	500,000
4. Office of Tracking and Data Acquisition.....	.....	300,000	300,000
a. Goldstone space communications complex.....	.....	300,000	300,000
Total.....	9,000,000	4,357,000	13,357,000

Office of Manned Space Flight-----	\$4, 650, 000
1. Kennedy Space Center (OMSF)-----	2, 100, 000
(a) Launch Complex 39-----	1, 845, 000
(1) Modification to Industrial Water Pumping Station: Installation of an additional 6,000 g.p.m. water pump with a one-bay addition to Pumping Station to provide firm fire protection supply for total demand at Pads A and B-----	(255, 000)
(2) Rehabilitation of Mobile Service Structure (MSS): Rehabilitate structural framing, modify floor panels, provide additional GN ₂ storage tanks and replace black steel GN ₂ pipe with stainless steel lines, and provide additional corrosion protection of MSS to maintain operational readiness-----	(554, 000)
(3) Rehabilitation of Launch Umbilical Tower (LUT) No. 1: Rehabilitate LUT No. 1 high speed elevators, replace inadequate metal floor panels with galvanized steel, provide additional environmental control equipment, modify chilled water piping, and provide additional corrosion protection to maintain operational readiness-----	(436, 000)
(4) Modification to S-IVB checkout cells, Vehicle Assembly Building: Modify S-IVB checkout cell work platforms in low bay "K," relocate high pressure gas and instrumentation systems to support AAP Orbital Workshop which is too large for available facilities-----	(600, 000)
(b) Industrial Area: Refurbish Altitude Chambers, Operations and Checkout Building: Completely refurbish or rehabilitate the two altitude chambers and their associated systems including the overhaul or replacement of mechanical and electrical equipment-----	255, 000
2. Manned Spacecraft Center-----	600, 000
(a) Manned Spacecraft Center—Houston: Erosion Control, Primary Drainage Ditches: Required to correct the existing erosion and sedimentation conditions of the primary drainage ditches. It is essential that existing erosion conditions be corrected to effect proper drainage-----	(100, 000)
(b) Ellington Air Force Base: Fire Protection Improvements to Hangars 135 and 276: Installation of fire detection and foam deluge or sprinkler systems in aircraft Hangars 135 and 276-----	(500, 000)
3. Marshall Space Flight Center-----	1, 025, 000
(a) Marshall Space Flight Center—Huntsville:	
(1) Improvements to Fire Protection Systems: Extensions and improvements of existing fire detection, alarm and water sprinkler systems to provide coverage in the buildings not presently covered by these systems-----	(250, 000)
(2) Modification, rehabilitation, and improvements to the air conditioning systems in Buildings 4619, 4485, and 4487-----	(250, 000)
(b) Michoud Assembly Facility: Rehabilitation of Air Conditioning Systems: Replacement of the louvers and supports that are deteriorating in the main cooling tower. Also, installation of an automatic deluge sprinkler system in cooling towers 117, 127, and 351. Included will be all piping, mounts, and sprinkler heads and heat activating devices and necessary alterations to the central fire alarm panels, etc-----	(300, 000)

(c) Mississippi Test Facility: Rehabilitation of Levee and Canals: Rehabilitate and improve the canal levees and dredge marginal canals to required depth-----		(\$225, 000)
4. Various Locations-----		925, 000
(a) Marshall Space Flight Center-----		625, 000
(1) Edwards Air Force Base: a. Rehabilitate Concrete Spillways and Reclamation Pond. Rehabilitate the concrete channels, spillways, and reclamation pond to prevent further erosion-----		(120, 000)
(2) Seal Beach Assembly Facility: a. Rehabilitate Air Conditioning Systems. Rehabilitate and improve the air conditioning systems in Buildings S-02 and S-03-----		(160, 000)
(3) Canoga Park—Air Force Plant No. 56: a. Capital-type Rehabilitation of Air Force Plant Used in Support of NASA Programs. Rehabilitate utilities and cranes. Rehabilitate and improve the utilities, factory lighting, and overhead cranes-----		(185, 000)
(4) Santa Susana—Air Force Plant No. 57: a. Capital-type Rehabilitation of Air Force Plant Used in Support of NASA Programs. Rehabilitate Propellant and Firex Water Systems. Rehabilitate hydrogen recovery system, LOX, hydrogen, LN ₂ and GN ₂ lines and the firex water systems-----		(160, 000)
(b) Manned Spacecraft Center:		
(1) Downey Industrial Plant: <i>Complete Rehabilitation of Roof of Manufacturing Building.</i> Two phases have already been completed at a cost of \$300,000. This project should complete roof repairs in this building-----		300, 000
Office of Advanced Research and Technology-----		2, 100, 000
1. Ames Research Center: (a) Rehabilitate oilers and Electrical System. Rehabilitate or modify the natural gas system and replace 8 inadequate heating system boilers. Modify the electrical system to revised safety codes and increased research demands-----		482, 000
2. Langley Research Center-----		725, 000
(a) Rehabilitate Building 648. Replace obsolete air-conditioning, electrical, and lighting systems. Replace wooden entrance doors and frames with aluminum to reduce heat loss and maintenance cost-----		(275, 000)
(b) Rehabilitate Building 1194. Rehabilitate roof framing system and roof, refurbish restrooms and exterior brickwork, and provide acceptable lighting--		(450, 000)
3. Lewis Research Center-----		640, 000
(a) Rehabilitate Utilities and Exhaust Gas Coolers. Extend domestic water system to correct deficient distribution system and rehabilitate PSL secondary exhaust gas cooler-----		(380, 000)
(b) Rehabilitate Mechanical Equipment in ERB. Rehabilitate combustion air dryer and compressor where distribution of equipment is causing research delays and airflow contamination-----		(260, 000)
4. Plum Brook Station: (a) Rehabilitate Electrical Systems and Reactor Equipment. Rehabilitate electrical system to provide increased capability to research buildings, and replace control rod poison sections at the reactor-----		253, 000
Office of Space Science and Applications-----		2, 250, 000

1. Goddard Space Flight Center-----	\$750,000
(a) Roof Repairs: This project provides for bituminous resaturation of the roofing felts and ventilation of wet roof insulation. The present roofing material has deteriorated to the point that it is no longer watertight -----	(50,000)
(b) Improve, Resurface Roads: This provides for patching of worn or damaged bituminous pavement on the Center. In addition, it provides for grading, resurfacing, and preparation of sideslopes of the roads at the Center, the Network Training and Test Facility -----	(150,000)
(c) Improve Central Chilled Water and Air-Conditioning Systems: Modifications to the Chilled Water Distribution System, the existing 6,000-ton cooling tower, and replace the existing 1,200-ton cooling tower. Modify or replace components of the air-handling units in various buildings.-----	(200,000)
(d) Upgrade Electric System: This project provides for the replacement of existing dry-type load transformers with liquid filled transformers, and existing air-frame and molded case main and tie circuit breakers with the airframe drawout type to improve reliability -----	(150,000)
(e) Rebuild Boilers (and Associated Equipment): Rehabilitation of 2 of the 5 boilers including the casings, refractory, and supporting equipment.-----	(200,000)
2. Jet Propulsion Laboratory-----	750,000
(a) Upgrade Utilities: Rehabilitation and replacement of air conditioners and cooling towers, storm drains and repairs, and sewerline repairs.-----	(170,000)
(b) Road Repair and Erosion Control: Rehabilitation and repair of roadways. Upgrading water systems and planting to control erosion. Rehabilitate parking lots -----	(400,000)
(c) Building Evacuation Alarm and Central Reporting System: Installation of a fire reporting, alarm, central recording system, and sprinkler systems.-----	(180,000)
3. Wallops Station -----	250,000
(a) Rehabilitation of Structures, Roads and Airstrip: Rehabilitation and resurfacing various sections of streets, roadways, and the 8,000-foot airstrip.-----	(100,000)
(b) Utilities Maintenance: Replacement of the underground central air distribution line and completion of the insulation of the aboveground steam distribution lines -----	(150,000)
4. Unmanned Launch Operations—KSC-----	500,000
(a) Upgrade Electrical System LC-17: Replace old electrical distribution system which was originally installed in 1957.-----	(110,000)
(b) Upgrade Communications System LC-17: Replace existing inadequate mops and monitor units two-wire system, with a new four-wire transistorized communications system -----	(150,000)
(c) Install Nitrogen Purge System LC-17: Installation of a nitrogen purge system for all communications systems on Launch Complex 17 Pads A and B to meet explosion-proof standards -----	(240,000)

Office of tracking and data acquisition----- 0

RESEARCH AND PROGRAM MANAGEMENT

Question 1a. What criteria was used to determine the requirement for \$20.1 million above the authorized amount to "sustain a minimum operating level"?

Answer. The requirement for a transfer of \$20.1 million to the "Research and program management" appropriation was determined after a detailed analysis of the effects of reducing our operations to a level of \$603.2 million and of the lowest level that would sustain, at a minimum rate, the programs approved by the Congress.

The analysis revealed that an operating budget of \$603.2 million would require, after all other reductions had been taken, a reduction of approximately 2,570 man-years of civilian employment in permanent positions. A reduction of this amount of effort could be accomplished only through a reduction in force by involuntary separation, which could not be planned any earlier than September 1, because of the procedural requirements for such action. In addition, it was estimated that employees would have an average of 15 weeks of salary after the RIF for payment of severance pay and terminal leave. This would mean that 4,900 positions would have to be vacated to generate the required man-year and dollar savings.

A reduction of 4,900 permanent civil service employees would have such disruptive effects that it would not be possible to carry out our approved programs. Our analyses indicated that through reductions in all areas of the "Research and program management" appropriation and the support contractor effort in Research and Development, it would be possible to effect savings in NASA consistent with the intent of Congress and the President to reduce expenditures, but which would provide a minimum adequate R. & P.M. plan to support the R. & D. programs. It was concluded that this could be accomplished at an appropriation level of \$623.3 million, \$24.9 million below this budget request. This level would provide for 31,186 employees in permanent positions, a reduction of 1,661 from the BOB-approved manpower plan.

Question 1b. What was the distribution of the \$20.1 million to field centers?

Answer. Because we could not construct an effective operating budget at the \$603.2 million level, no distribution was made of the \$603.2 million by center. Accordingly, no distribution of the \$20.1 million increase was made by center.

Question 1c. What was the distribution of the \$20.1 million by functional category on an agencywide basis?

Answer. Since it was not possible to prepare a viable program at the \$603.2 million level, no distribution was made at the functional level. Therefore, there is no functional distribution of the \$20.1 million transfer.

Question 1d. According to justification presented last year, the cost of the second increment of the 1967 Federal Employees Pay Act was not included in the 1969 NASA request, but had been included elsewhere in the President's budget as a single line item for all Government

departments and agencies. According to this year's justification, NASA absorbed the second pay raise increment by transferring \$23.7 million from the fiscal year 1969 R. & D. appropriation. Why was this not financed from the separate Government-wide line item included in the President's budget?

Question 1e. Was any attempt made to secure these additional funds for the pay raise from BOB before invoking the section 4 transfer authority?

Answer. The Bureau of the Budget determined that it was not necessary to provide financing from other sources since the amount was available within the funds withheld from the Research and Development appropriation as a result of the reductions required in accordance with the Revenue and Expenditure Control Act of 1968. Accordingly, the Bureau of the Budget provided the funds necessary for the salary increase from funds withheld from the Research and Development appropriation, which were not otherwise available to NASA.

Question 1f. According to the fiscal year 1970 justification, NASA, with the approval of the Bureau of the Budget, plans to convert 810 service support contract positions to civil service at the Goddard Space Flight Center. Five hundred and fifty-nine of these positions will be converted in fiscal year 1969, which occasioned the transfer of \$1,541,000 from the R. & D. to the Administrative Operations appropriations of fiscal year 1969. This is the second such conversion at Goddard.

(1) Are any further conversions envisioned at Goddard?

Answer. NASA does not currently anticipate any conversion of other activities to a civil service operation, beyond the 810 positions at Goddard.

(2) Have similar conversions been made at other centers? If not, why?

Answer. No other major conversions have been made at other centers although some minor conversions have been made. The GSFC conversions were made because the close working relationships established in setting up the support contracts resulted in situations which, in the Civil Service Commission's view, were or could be improper. The conversions were made where changes in the working relationships that would preclude such an interpretation by CSC were not possible. In other centers, some adjustments of contractual arrangements in obtaining support contracts have been made to assure that working relationships were consistent with personnel laws.

(3) Are studies being made at other centers to determine if further conversions should be made? Which centers?

Answer. In July 1968, the Civil Service Commission issued an amendment to the CSC General Counsel's determination that two support service contracts at GSFC were proscribed by the personnel laws of the United States. This emphasized that supervision of contractor employees by the Government was the legal criterion to be applied to contracts for services. Based on these clarified standards, NASA's examination of its contracts has continued. Surveys have been completed at Ames, Electronics, Flight, Langley, and Lewis Research Centers. In addition, center management studies have been completed

at GSFC and Marshall Space Flight Center. As noted above, based on these analyses and reviews, adjustments of NASA's contractual arrangements in obtaining its support services have been made and are continuing to be made.

(4) Are there apt to be further conversions during fiscal year 1970 which will generate a requirement for additional funds not included in the fiscal year 1970 authorization request?

Answer. While studies are now underway throughout the agency, NASA has no present intention to convert other support service contracts to civil service operations.

Question 2a. How much is included for nonpermanent employees?
\$5,185,000.

Question 2b. What is the planned distribution of the nonpermanent positions and funding by centers?

Answer. The following table reflects the fiscal year 1970 estimates for nonpermanent positions and funding by center.

FISCAL YEAR BUDGET ESTIMATES—NONPERMANENT POSITIONS AND FUNDING BY CENTER

	Number of positions (June 30, 1970)	Amount (in thousands)
Kennedy Space Center.....	132	\$411
Manned Spacecraft Center.....	369	976
Marshall Space Flight Center.....	495	1,355
Goddard Space Flight Center.....	250	382
Wallops Station.....	71	88
Ames Research Center.....	113	246
Electronics Research Center.....	156	335
Flight Research Center.....	56	129
Langley Research Center.....	182	415
Lewis Research Center.....	131	192
Headquarters.....	238	656
Total.....	2,193	5,185

Question 2c. The ratio of direct to indirect positions for FY 1970 is about 2.3 to 1 according to the justification. How does this compare with previous years? How does this ratio compare with industry?

Answer. The ratio of direct to indirect positions of approximately 2.3 to 1 estimated for fiscal year 1970 has been constant since FY 1965. Based on our most recent experiences with contractors performing NASA tasks, the comparable rates for industry is about 2 to 1.

Question 3. How much is included in the FY 1970 authorization for overtime and holiday pay? What basis was used to arrive at this figure? What is the distribution of these funds by center?

Answer. \$7,374,000 is included in the FY 1970 estimates for overtime and holiday pay. The overtime estimate for FY 1970 was based primarily on our current experience, with the objective of maintaining the lowest rate compatible with efficient operations. The overtime estimate is about half of the overtime cost in FY 1966, when overtime was 4.2 percent of permanent compensation. The percentage of compensation in succeeding years were 2.4 percent in FY 1967 and 1.6 percent in FY 1968 and is estimated at 1.7 percent in FY 1969 and 1.8 percent in FY 1970. The increase of \$458,000 in FY 1970 over FY 1969 is required to support the Saturn V/Apollo flight activity, which is consistent with the rates experienced for FY 1969 missions. The following table shows the distribution of these funds by center for FY 1970.

FY 1970 BUDGET ESTIMATES

OVERTIME AND HOLIDAY PAY

	<i>Thousands of dollars</i>
Kennedy Space Center.....	\$2, 521
Manned Spacecraft Center.....	1, 742
Marshall Space Flight Center.....	898
Goddard Space Flight Center.....	685
Wallops Station.....	111
Ames Research Center.....	50
Electronics Research Center.....	50
Flight Research Center.....	131
Langley Research Center.....	222
Lewis Research Center.....	732
Space Nuclear Propulsion Office.....	3
Headquarters.....	229
Total	\$7, 374

Question 4. In April 1968, NASA reported that 32,289 contract personnel were employed under service support contracts at the various centers. The total annual cost of these contracts was reported as \$436.4 million, of which \$87.8 million was financed out of the Research and Program Management appropriation (then titled "Administrative Operations") and \$348.6 million was financed out of the R. & D. appropriation. Please provide for the record the comparable figures for FY 1970 broken down by center.

Answer. The April 1968 report was for FY 1968. The currently available cost detail is for FY 1969 and is tabulated below. The FY 1970 cost data, which will be developed at a later date, is expected to approximate the FY 1969 data.

Installation	Costs (thousands)			Total
	Man-year equivalents	R. & P.M. appropriation	R. & D. appropriation	
Total	31, 825	\$76, 614	\$386, 280	\$462, 894
Ames.....	388	353	5, 537	5, 890
Electronics.....	135	1, 055	880	1, 935
Flight.....	426	1, 055	11, 739	12, 794
Goddard.....	6, 911	4, 003	112, 557	116, 560
Headquarters.....	786	5, 924	12, 818	18, 742
Kennedy.....	9, 703	35, 740	75, 249	110, 989
Langley.....	729	1, 865	6, 238	8, 103
Lewis.....	303	2, 338	-----	2, 338
Manned.....	7, 595	11, 280	107, 102	118, 382
Marshall.....	4, 646	12, 364	52, 585	64, 949
Wallops.....	203	637	1, 575	2, 212

Question 5. The request for Automatic Data Processing included in the FY 1970 Research and Program Management appropriation is \$23.8 million. How much is included in the R. & D. appropriation for Automatic Data Processing, including programing and operation services?

Answer. The amount included in the R. & D. budget is \$109.1 million.

Question 6. How much is included in the FY 1970 Research and Program Management appropriation for minor construction and modifications? Provide for the record a complete list of the projects and their costs planned for FY 1970 by Center.

(a) *How much of the R. & D. appropriation will be used for minor construction and modifications? Provide for the record a complete list of projects to be undertaken, including the cost estimate of each project, broken down by Center.*

Answer. Attached is a listing of projects currently proposed for funding from the FY 1970 R. & D. and R. & P.M. Minor Construction and Modifications (Lands and Structures) category. This listing is a current evaluation of requirements in this category. However, during the course of the budget year, new requirements can be expected to emerge, or priorities may change, so that the listing as presently shown can be expected to vary from time to time. For this reason, NASA updates its minor construction and modifications plan at least semiannually.

NASA-WIDE SUMMARY

MINOR CONSTRUCTION AND MODIFICATIONS

R. & D. AND R. & P.M.

It is currently estimated that minor construction and modification projects will be undertaken in FY 1970 by the various program offices in the approximate amounts shown below. These amounts are supported by listings setting forth the project location, description, and estimated cost now envisioned. These listings reflect a current evaluation of needs and priorities. However, it is anticipated that during the budget year, new requirements will emerge and priorities may have to be revised.

Program office	R. & D.	R. & P.M.	Total
Office of Manned Space Flight.....	\$6,112	\$459	\$6,571
Office of Advanced Research and Technology.....	1,568	365	1,933
Office of Space Science and Applications.....	1,434	329	1,763
Office of Tracking and Data Acquisition.....	1,386	0	1,386
NASA total, fiscal year 1970.....	10,500	1,153	11,653

RESEARCH AND DEVELOPMENT

MINOR CONSTRUCTION AND MODIFICATIONS SUMMARY

Program office	Amount
Office of Manned Space Flight.....	\$6,112.0
Office of Advanced Research and Technology.....	1,568.0
Office of Space Science and Applications.....	1,434.0
Office of Tracking and Data Acquisition.....	1,386.0
Total	10,500.0

OFFICE OF MANNED SPACE FLIGHT SUMMARY

Location	Amount
Kennedy Space Center.....	\$751.0
Manned Spacecraft Center.....	2,280.0
Marshall Space Flight Center.....	2,127.0
Michoud Assembly Facility.....	383.0
Mississippi Test Facility.....	373.0
Various Locations.....	198.0
OMSF Total, FY 1970.....	6,112.0

<i>Kennedy Space Center</i>	<i>Amount</i>
Additions and Modifications to Specialized Fire Suppressions Systems, VAB and LCC-----	\$74.2
Modifications to High-Speed Elevators, LC 39-----	75.0
Modifications to Secondary Electrical Systems, Pads A and B, LC 39-----	150.0
Increase Spacecraft and Vehicle Parts Storage Capacity, VAB Parts Crib-----	33.8
Enlarge Enclosed Area of Platform No. 3, MSS-----	143.0
Safety Lighting, Pads A and B, LC 39 Support Areas-----	24.0
Cross Connect Industrial Water and Firex Lines at Pad A-----	27.0
Improve Launch Complex 16 to Provide Hypergolic GSE Servicing and Calibration Capability-----	224.0
Total, FY 1970-----	751.0

Manned Spacecraft Center

	<i>Amount</i>
Extension of High Bay Area, Building 33, Space Environment Simulation Laboratory-----	\$110.0
Install an Existing Ultra High Vacuum Chamber, Building 13-----	25.0
Modifications for AAP Power Systems Testing-----	150.0
Modify Liquid and Gaseous Oxygen Impact Test Facility-----	50.0
Additions to Building 7 for High Bay and Lab Space-----	240.0
Modifications to Building 260 to Enlarge High Bay Area-----	240.0
Install LN ₂ Lines, Building 32-----	35.0
Conversion of Visual Room in Building 5 to Simulation Support Area-----	100.0
Install Seismic Mass Air Suspension, Building 49-----	35.0
Acoustic Treatment of S/C Vibration and General Vibration Labs, Building 49-----	40.0
Modifications to LN ₂ , Air and Helium Subsystems, Building 32-----	240.0
Modifications to LN ₂ , Air and Helium Subsystems, Building 35-----	235.0
Modifications to Humidity Control, Building 16-----	40.0
Modifications to Display System, Building 30-----	65.0
Modifications to Mission Control Communications Subsystems, Building 30-----	75.0
Modifications for Interfacing Real Time Computer Complex, Building 30-----	50.0
Projects under \$10,000-----	550.0
Total, FY 1970-----	2,280.0

Marshall Space Flight Center (Huntsville)

Construct Clean Room, Assembly Area, Building 4755-----	\$145.0
Install Environmental Control Welding Shop, Building 4705-----	125.0
Install Environmental Control High Bay Area, Building 4707-----	235.0
Install Environmental Control Plastic Shop, Building 4759-----	75.0
Installation of Potting and Encapsulation Facility for Filght, GSE, and Prototype Electronic Components, Building 4493-----	30.0
Modify GN ₂ Reduction Stations, Building 4475-----	25.0
Modification of LN ₂ Storage Facility, Building 4476-----	25.0
Modify Solar Actuator Facility, Room A-120, Building 4487-----	60.0
Install Sodium-Potassium (NAK) Loop, Building 4475-----	20.0
Install Existing Thermal Vacuum Chambers in Building 4476-----	15.0
Modify Thermal-Shroud Checkout Facility for ATM Component Testing-----	15.0
Modification ATM Control Room-----	25.0
Modification F-1 Engine CO Station-----	10.0
Expand X-Ray Facility-----	10.0
Install Cryogenic System for Low Density Wind Tunnel, Building 4732-----	225.0
Modification to Cell 115 for Hydrogen Investigation Capability-----	50.0
Additions to Test Stand 300 for Vacuum Test Support Equipment-----	100.0
Addition to Air Compressor Facility, Building 4647-----	240.0
Modification to High Pressure Gas Distribution Systems-----	190.0
Construct Addition to Laboratory and Inspection Areas for AAP Component Work, Building 4752-----	210.0
Addition to Magnetic Tape Certification Facility, Building 4663-----	42.0
Modification to Ventilation System, S-IC Stand-----	120.0
Projects under \$10,000-----	135.0
Total, FY 1970-----	2,127.0

Michoud Assembly Facility

	<i>Amount</i>
Install New Mooring Pile Clusters Adjacent to S-IC Barge Dock-----	\$15
Modify S-IC Subsystem Test and Clean Room Facilities-----	15
Building 103—Equipment Foundation-----	25
Install Companion Electrical Feeder, Buildings 320 and 350-----	12
Installation of Lightning and Surge Protectors-----	45
Install Emergency Announcing Systems, Building 350-----	31
Install Automatic Alarm, Shut-off, and Venting Capability for High Pres- sure Gases in Building 111 Test Cells-----	35
Color Coding of Plant Piping System-----	30
VAB Modifications-----	75
Projects under \$10,000-----	100
Total, FY 1970-----	383

Mississippi Test Facility

	<i>Amount</i>
Automation of High Pressure Gas Facility-----	\$155
Addition of Inspection Manways in High Pressure Gas Vessels-----	125
Addition of Inspection Manways in High Pressure Air and Helium-----	80
Projects under \$10,000-----	13
Total, FY 1970-----	373

*Various Locations (OMSF)**Seal Beach:*

	<i>Amount</i>
Foundation for Common Bulkhead Concentricity Test, Bulkhead Fabrication Building-----	\$100
Power Redistribution, Building S-05-----	10
Emergency Lighting VAB, Buildings S-14 and S-18-----	30
Projects under \$10,000-----	43
Seal Beach total, FY 1970-----	183

Sacramento: Projects under \$10,000-----

Sacramento total, FY 1970-----	15
Total, FY 1970-----	198

OFFICE OF ADVANCED RESEARCH AND TECHNOLOGY

SUMMARY

<i>Location</i>	<i>Amount</i>
Ames Research Center-----	\$690
Flight Research Center-----	50
Langley Research Center-----	123
Lewis Research Center-----	705

OART total, fiscal year 1970----- 1,568

Ames Research Center

	<i>Amount</i>
Construct clean room in space equipment fabrication area-----	\$225
Construct ground board boundary layer removal system in 40' x 80' wind tunnel-----	225
Install variable height structure in subsonic wind tunnel-----	225
Projects under \$10,000-----	15

Total, fiscal year 1970----- 690

Flight Research Center

Modifications to range station-----	<i>Amount</i> \$50
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Total, fiscal year 1970----- 50

Langley Research Center

	<i>Amount</i>
Cooling tower addition to Building 1221-----	\$73
Projects under \$10,000-----	50

Total, fiscal year 1970----- 123

<i>Lewis Research Center</i>	<i>Amount</i>
Install Combustion Air Dryer, Dessicant Type, for PSL-----	\$240.0
Repair and Alteration of High-Temperature Instrument Calibration Tunnel, Room CE 13, ERB-----	15.0
Install High Resolution Periscope at SW-23 and SW-24, ERB, to Monitor Combustion Flames-----	10.0
Convert Valve Controls from Pneumatic to Electrohydraulic, SW-23 and SW-24, ERB and at PSL, Cells 1 and 2-----	10.0
Install Scanivalve Type Pressure Measuring System, 8' x 6' and 10' x 10' Tunnels and in SW-21, ERB-----	15.0
Replace Controls for 10' x 10' Supersonic Wind Tunnel with Solid State Controls-----	20.0
Activate 450 PSI Heater and Turbojet Simulator at the 8' x 6' Supersonic Wind Tunnel-----	10.0
Modification of the Return Leg of the 8' x 6' Supersonic Wind Tunnel, to Permit Short Duration Transition and Start-up Tests of Hot Direct-Lift Engines within the V/STOL Test Section-----	220.0
Modify Air Exhaust System of Special Projects Laboratory to Accommodate an Erosion-Corrosion Laboratory-----	10.0
Special Type Painting at Plum Brook Station Reactor-----	20.0
Replace Motor for Shutdown Pump at Plum Brook Station Reactor-----	30.0
Projects under \$10,000-----	105.0
Total, FY 1970-----	705.0

OFFICE OF SPACE SCIENCE AND APPLICATIONS SUMMARY

<i>Location</i>	<i>Amount</i>
Goddard Space Flight Center-----	\$484.0
Jet Propulsion Laboratory-----	900.0
Wallops Station-----	50.0
OSSA Total, FY 1970-----	1,434.0
<i>Goddard Space Flight Center</i>	<i>Amount</i>
Addition to Data Interpretation Lab-----	\$230.0
Modifications to Propulsion Research Facility-----	50.0
Projects under \$10,000-----	204.0
Total, FY 1970-----	484.0
<i>Jet Propulsion Laboratory</i>	<i>Amount</i>
Addition to Building 200-----	\$150.0
Construct South Addition to Building 170-----	200.0
Construct Second Floor Addition, Building 179, South Wing-----	250.0
RTG Prototype Development Modification to Building 247 and OART Requirements-----	230.0
Projects under \$10,000-----	70.0
Total, FY 1970-----	900.0
<i>Wallops Station</i>	<i>Amount</i>
Projects under \$10,000-----	\$50.0
Total, FY 1970-----	50.0

OFFICE OF TRACKING AND DATA ACQUISITION SUMMARY

<i>Location</i>	<i>Amount</i>
Deep Space Network (DSN)-----	\$328.0
Manned Space Flight Network (MSFN)-----	570.0
Space Tracking and Data Acquisition Network (STADAN)-----	488.0
OTDA Total, FY 1970-----	1,386.0

Deep Space Network

	<i>Amount</i>
Provide Radio Frequency Protection (DSS 14), Goldstone-----	\$33.0
Install Grounding System, Space Flight Operations Facility (SFOF)-----	42.0
Expand Fire Detection, SFOF-----	89.0
Projects under \$10,000-----	164.0
Total, FY 1970-----	328.0

Manned Space Flight Network

	<i>Amount</i>
Construct Addition to Storage and Test Calibration Building, Ascension Island-----	\$50.0
Install Pre-Fab Administration Building, Grand Bahama-----	20.0
Service Maintenance Building Addition, Hawaii-----	70.0
Building Modifications, Network Test and Training Facility, Goddard Space Flight Center-----	230.0
Projects under \$10,000-----	200.0
Total, FY 1970-----	570.0

Space Tracking and Data Acquisition

	<i>Amount</i>
Install Scamps and/or Transmitters Facilities, Rosman, Santiago, Quito, Canberra, and Newfoundland-----	\$150.0
Install Receive and Command Antennas, Kauai, Hawaii-----	75.0
Install Fire Detection System, Mojave, Winkfield, Johannesburg, and Canberra-----	100.0
Install Fire Fighting Equipment, Canberra, Lima, Mojave, Rosman, and Winkfield-----	75.0
Install Power Generator (500 KW), Canberra-----	70.0
Projects under \$10,000-----	18.0
Total, FY 1970-----	488.0

RESEARCH AND PROGRAM MANAGEMENT MINOR CONSTRUCTION AND MODIFICATIONS—NASA-WIDE SUMMARY

Program Office

	<i>Amount</i>
Office of Manned Space Flight-----	\$459.0
Office of Advanced Research and Technology-----	365.0
Office of Space Science and Applications-----	329.0
NASA total, FY 1970-----	1,153.0

OFFICE OF MANNED SPACE FLIGHT—SUMMARY

Location

	<i>Amount</i>
Kennedy Space Center-----	\$259.0
Manned Spacecraft Center-----	100.0
Marshall Space Flight Center-----	100.0

OMSF Total, FY 1970-----	459.0
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Kennedy Space Center:

	<i>Amount</i>
Modify Power System Operations and Shop Area-----	\$70.0
Install New Flushing Hydrants-----	27.5
Replace Open Wire with Aerial Cable, Kennedy Parkway-----	25.4
Replace Aerial Cable with Underground Cable, D Avenue-----	37.1
Additional Traffic Lanes, Visitors Information Center Intersection-----	36.0
Emergency Power for Fire, Security and Medical Facilities, LC 39 and Industrial Area-----	23.0
Automatic Controls for Water and Sewage System-----	40.0
Total, FY 1970-----	259.0

<i>Manned Spacecraft Center:</i>	<i>Amount</i>
Construct Access Road, 300 Area	35.0
Upgrade Fire Detection and Alarm System (300 and 400 Areas)	44.0
Projects under \$10,000	21.0

Total, FY 1970 100.0

<i>Marshall Space Flight Center (Hu)</i>	<i>Amount</i>
Modifications to Building 4471 for Supporting Purchasing Branch	25.0
Modifications to Training Facility	20.0
Projects under \$10,000	55.0

Total, FY 1970 100.0

OFFICE OF ADVANCED RESEARCH AND TECHNOLOGY SUMMARY

<i>Location:</i>	<i>Amount</i>
Flight Research Center	\$75.0
Langley Research Center	280.0
Lewis Research Center	30.0

OART total, FY 1970 365.0

<i>Flight Research Center:</i>	<i>Amount</i>
Re-roof Calibration and Main Hangars	40.0
Projects under \$10,000	35.0

Total, FY 1970 75.0

<i>Langley Research Center</i>	<i>Amount</i>
Building 1192 (ASPO Project Office) Alterations	\$12.0
Building 1230 (Instrument Control) Alterations	50.0
Building 1244 (Consolidation of Engineering Services)	52.0
Modification to Air Conditioning	70.0
Projects under \$10,000	76.0

Total, fiscal year 1970 260.0

<i>Lewis Research Center</i>	<i>Amount</i>
Marvin Road Widening	\$15.0
Projects under \$10,000	15.0

Total, fiscal year 1970 30.0

OFFICE OF SPACE SCIENCE AND APPLICATIONS SUMMARY

<i>Location</i>	<i>Amount</i>
Goddard Space Flight Center	\$205.0
Wallops Station	124.0

OSSA total, fiscal year 1970 329.0

<i>Goddard Space Flight Center</i>	<i>Amount</i>
Provide Fire Protection for Tape Storage Area, Building 16	\$77.0
Air Conditioning Modifications to Computer Area, Building 18	15.0
Modifications to Air Handling Units, Various Buildings	48.0
Renovation for Tape Rehabilitation Lab, Building 19	50.0
Projects under \$10,000	15.0

Total, fiscal year 1970 205.0

<i>Wallops Station</i>	<i>Amount</i>
Modification to Building X-15 for Payload Checkout	\$104.0
Projects under \$10,000	20.0

Total, fiscal year 1970 124.0

FACILITY PLANNING AND DESIGN

For Facility Planning and Design, NASA has requested \$3,500,000 for fiscal year 1970.

Question. What is the total amount authorized for Facility Planning and Design for (1) fiscal year 1968 and prior years and (2) fiscal year 1969?

Answer. The amounts authorized for Facility Planning and Design are:

Fiscal year 1968 and prior years-----	\$69,347,500
Fiscal year 1969-----	1,000,000
Total -----	70,347,500

Question. Of the total amount authorized for Facilities Planning and Design, how much has been funded?

Answer. Of the total amount authorized for Facilities Planning and Design \$53,480,816 has been funded.

Question. How much of the authorization for Facilities Planning and Design has expired as a result of the automatic rescission provision?

Answer. Since the beginning of the NASA Program \$89,669,000 of authorization to appropriate for construction of facilities has expired as a result of the automatic rescission provisions. The F.P. & D. portion of the \$89,669,000 total is \$11,862,000.

Question. What amount has been obligated of the total authorized for Facilities Planning and Design?

Answer. All but \$2.1 million of F.P. & D. funds has been obligated, and of this, all but \$330,000 will have been obligated by June 30, 1969.

Question. What is the proposed disposition of \$330,000 which will be unobligated in Facilities Planning and Design by June 30, 1969?

Answer. We are in a deficit position and are withholding some starts such as final design of fiscal year 1970, some fiscal year 1971 PER's, and we would like to release PER funds for fiscal year 1972 in the first quarter of fiscal year 1970. The \$330,000 will be applied to some of these requirements, but it will not suffice for all.

Question. Provide a breakout of the \$2.1 million unobligated balance of Facilities Planning and Design funds.

Answer:

	<i>In thousands of dollars</i>
	(\$000)
(a) Unobligated balances F. P. & D. Mar. 31, 1969 (Estimated)-----	2,130
Projected Obligations Mar. 31-June 30, 1969-----	-1,800
Continuing Design fiscal year 1968 and prior projects: principally for Modification and Rehabilitation to LC 34 and 37 and the Environmental Testing Lab-----	(175)
Final Design fiscal year 1970 Projects-----	(960)
Preliminary Engineering for fiscal year 1971 Projects-----	(450)
Special Studies-----	(215)
Carryover to fiscal year 1970-----	330

(b) Additional F.P. & D. requirement for fiscal year 1969 and Prior Projects	2, 710
Completion of Design of fiscal year 1969 and prior projects: principally for Phased Array Antenna System, Mods to the Environmental Testing Lab, Launch Complex 39, Equipment for the Hypersonic Propulsion Research Lab and Master Planning.....	(369)
Final Design fiscal year 1970 Projects.....	(1, 334)
Preliminary Engineering fiscal year 1971 Projects.....	(722)
Special Studies.....	(285)
Carryover for Application to above requirements.....	-330
Unfunded fiscal year 1969 and Prior Requirements.....	2, 380

Question. Provide a breakout of the 3.5 million (fiscal year 1970) by Program Office.

Answer. The \$3.5 million F.P. & D. requested for fiscal year 1970 is forecast by program offices as follows:

	Millions
Office of Manned Space Flight.....	\$0. 95
Office of Space Science and Application.....	1. 05
Office of Advanced Research and Technology.....	1. 15
Office of Tracking and Data Acquisition.....	. 35
Total	3. 50

This forecast is based on preliminary inputs as to potential priority needs. In our judgment, the \$3.5 million will only meet the most urgent needs and the breakout by program office given above will of necessity be revised as program needs and priorities evolve in more detail.

Question. Can any authorized CofF funds be redirected to the unfunded authorization for Facility Planning and Design?

Answer. Although the unfunded authorization for the Facility Planning and Design Account totals \$4.5 million for fiscal year 1967 and 1968, there are no funds currently available within NASA to finance this unfunded authorization. Appropriations for Construction of Facilities totalled \$83.0 million in fiscal year 1967, or \$12.9 million less than the authorization, and \$35.9 million in fiscal year 1968 or \$34.0 million less than the authorization. The differential between authorization and appropriations has effectively resulted in the deferral of needed projects, and a reduction in the amounts which could be applied against Facilities Planning and Design. Since then the problem of funding has not improved appreciably. NASA continuously reviews all unobligated balances available to the Agency, and whenever possible such funds have been redirected and applied to essential requirements. However, currently authorized construction for which a valid and pressing need still exists continue to outpace the availability of funds. Therefore, there are no funds now available to apply against unfunded Facility Planning and Design Authorization. As a consequence, the fiscal year 1970 request of \$3.5 million for Facility Planning and Design represents a minimal amount to execute the planning activities so necessary to achieve maximal utilization of the NASA facilities plant in support of future programs, and to proceed with the design of programed facilities.

