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Report of the Task Force on Space

January 8, 1969

Preamble

Development of space sciences and technology, exploitation of their uses, and exploration of the solar system inspire and attract human endeavor for many reasons. Since much effort and expense are involved, and plans for major moves in these fields must be made years in advance, it is prudent for any nation to consider carefully what, in the course of years and decades, is the likely importance and cost of such efforts to the nation and to humanity. Yet no one can assess with precision or surety the ultimate human value of our space program, and indeed we can expect that some of the more striking values are not yet visualized. However, what can now be foreseen, and historical experience in development of other areas of science and technology, make a convincing case that space exploration and utilization will have a tremendous impact on human thought, activity, and welfare. The space program has many facets, and the values of each cannot always be measured on the same scale. The more important aspects, not in order of priority, are:

1. ***Exploration and Discovery.*** Man's escape from the earth's surface, his exploration of the moon and planets and further penetration, at least by instruments, of space beyond the solar system represent one of the most exciting and appealing frontiers for human exploration of all time. Linked so closely with exploration as to not be really separable is a second aspect—

2. ***Science.*** The space program has provided new tools and unique capabilities for examination of some of the most challenging and basic scientific questions. For example, space observatories will have an important influence on our understanding of the history of the universe and yield enormous advances in astronomy, newly possible lunar and planetary [2] investigations should answer questions on the formation of the solar system and greatly increase our knowledge of geophysics, and exobiology may revolutionize our view of life.

3. ***Use of Spacecraft and Associated Techniques for Civil or Commercial Benefit.*** Some applications of space operations, such as communications satellites, already seem to be economical in terms of direct benefits to civilian life. Others, like weather-observing satellites, coupled with new sensing systems, offer realistic prospects of great advances in weather research and its applications. In such diverse areas as mineral and water resource development, forest and agricultural surveillance, and ocean monitoring, for example, substantial advances seem imminent and warrant vigorous research and development. In all of these cases, space technologies open up entirely new opportunities for achieving the global perspectives that are essential to the effective use of world resources and to the preservation or improvement of the quality of the human environment.

4. ***World Cooperation and Stability.*** Many aspects of space work stimulate and offer new opportunities to promote world unity and cooperation. Important among these are the fulfillment of common human aspirations in extending man's purview beyond the earth itself, the physical and logical impossibility of dividing space or satellite orbits along national lines, and the naturalness of global utilization of space operations. While capitalization on these aspects in the interest of world unity and stability will require care and subtlety, they do present new and potent opportunities for progress in this direction.

5. ***National Security.*** If one omits consideration of ballistic missiles, as we shall, there are still a large number of important direct applications [3] of space technology to military effectiveness. The DOD budget of about $2 billion for space work is an indication, and we think a reasonable reflection, of the present importance of military applications of space. Furthermore, the probability of additional unappreciated effects of space technology on military affairs and the rapidity of change in military technology give considerable importance to a high level of U.S. competence in all major areas of space technology and operations. Closely related to some aspects of national security is the question of—

6. ***Prestige.*** Prestige comprises a variety of real and sensible effects on the attitudes and responses of the U.S. citizenry, as well as other peoples. They are important to the confidence and well-being of our own citizens as well as to our international actions and national security. Prestige associated with space must in the long run be based, of course, on real values rather than on the appearance of accomplishment, and its effects need to be carefully judged by those versed in politics and social psychology, who at the same time are well informed about the technical and operational possibilities of the space program.

7. ***Technological Development.*** A successful space program gives not only the appearance of technological and organizational leadership, its stringent requirements demand and develop them. There are other conceivable technological programs, mostly less highly visible, which can give similar benefits for the general development of technology. However, the existence of a vigorous space program does provide an important stimulus to technology, and helps give U.S. industry a favorable competitive position in world markets.

[4] Summary of Issues and Conclusions

Major issues and considerations in the present direction of the nation's space program are as follows:

1. ***Should the U.S. compete with the USSR in space activity?*** We believe it should not do so in detail, but that the U.S. effort must be as strong over-all as that of the Soviet Union. A decision to compete on this broad scale plays an important role in the budgetary level of space work, fixing it at something like the present level.

2. ***Is any significant change required in thrust or content of the present space program?*** A new look is required at the balance between the manned and unmanned segments of NASA space program, in order to ensure that the purposes and relative usefulness of each is properly assessed and fully exploited. Expanded research and development in use of unmanned devices for scientific investigation, and in a wide variety of useful applications, including communications, weather and earth resources surveys, seems strongly indicated.

3. ***What should be the objectives and scope of the manned program?*** While this issue is complex, and the function of man in space not yet clear, a considerable majority of the task force believes there is a substantial role for man in the long term, and that a continued manned flight program, including lunar exploration, is justified at present.

4. ***What are the program items and their urgency for the immediate future?*** Various items needing special consideration are

a. A manned space station. We are against any present commitment to the construction of a large space station, but believe study of the possible purposes and design of such a station should be continued.

[5] b. Apollo Applications Program. This program should proceed as a way of testing man's role in space, of allowing a healthy continuing manned space program, and for the biomedical and scientific information it will yield.

c. Lunar exploration. Lunar exploration after the first Apollo landing will be exciting and valuable. But additional work needs to be initiated this year to provide for its full exploitation by means of an adequate mobility and extended stay on the lunar surface.

d. Planetary exploration. The U.S. program for planetary exploration by instrumented probes needs to be strengthened and funds for such probes increased appreciably. However, the great majority of the task force is not in favor of a commitment at present to a manned planetary lander or orbiter.

e. Astronomy and other sciences. The space program is important to a number of sciences, and can be of enormous benefit to astronomy. This potential should be continuously developed through sound and stable programs.

f. Applications of spacecraft and associated techniques for civil and commercial benefit. We believe research and development of such applications should be supported strongly and increased in pace. Furthermore, the new administration should give considerable attention to their use in promoting international cooperation.

5. ***The significance of space work to national security.*** The space program is of great importance to national security, not only because of present direct military applications, and its effect on our posture, but also [6] to have available the necessary technology and skill to make or counter new military uses of space. Recommendations are discussed in a classified appendix.

6. ***Cost reduction, and "low cost" boosters.*** The unit costs of boosting payloads into space can be substantially reduced, but this requires an increased number of flights, or such an increase coupled with an expensive development program. We do not recommend initiation of such a development, but study of the technical possibilities and rewards. Some cost reductions in the space program can probably be made simply through experience and stabilization of the level of effort, and through coordination of future NASA and DOD programs.

7. ***International affairs.*** Space operations put in a new light many international questions and also lead naturally towards some areas on international cooperation. We believe these offer opportunities for initiatives and some progress towards world cooperation and stability, and the U.S. should exploit these opportunities with both care and vigor.

8. ***Are organizational arrangements appropriate for the future space effort?*** We believe the separation of nonmilitary from military space work which has been effectively produced by the creation of NASA, and the continuance of a strong, largely unclassified, space program without any direct military aspects is very important.

Organizational programs which need action or study include:

a. The DOD/NASA interface, where it is recommended that the new heads of the two organizations develop a plan for optimizing coordination.

b. The NASA organizational structure. Sometime after the first lunar landing, NASA should be reorganized on a more [7] functional basis rather than on a basis of use of manned or unmanned techniques, and in addition an out-standing scientist should be brought into its top administrative ranks.

c. The Space Council has not been very effective. We recommend changes.

The appropriate over-all budgetary level and rate of the space effort cannot be made precise without detailed examination. However, three considerations dominate in the general budgetary level required for the space program. One is the needed development and application of space technology directly for military problems. We have not examined the DOD budget of $2 billion for these purposes, but such a figure seems appropriate. A second is the need we see for a continued manned space flight program. For a successful, safe, and continuing manned program in NASA an annual budget of about $2 billion directly for this purpose is needed for fiscal 1970. Additional funds are of course necessary for many other parts of the NASA program, including some expansion on unmanned exploratory work. The third large and very pervasive factor affecting the budget is the need to maintain a generally competitive position with respect to the Soviet Union. We believe that approximately the present level of expenditure, $6 billion for the total space program, and about $4 billion for NASA, is needed for this purpose. This total amount, about $^3/_4$ of one per cent of the GNP, does not seem excessive in view of importance of the space developments to the nation.

A $4 billion budget represents a rather frugal amount to carry out NASA's many important tasks. But we believe it is adequate for the programs recommended here. In subsequent years some changes may be appropriate, [8] but we do not expect that any large fractional change will be desirable soon without a concomitant substantial change in the role of NASA or in the international situation.

The most reasonable way of effecting a large budget reduction in the future would be to postpone any development of new manned systems. Since most of the development and hardware purchases for Apollo have now been made and considerable number of boosters and space vehicles will remain after the first lunar landing, it is possible to have an active and successful manned program for several years while at the same time steadily

decreasing the level of funding for manned space flight to perhaps $1.25 billion by fiscal 1972. This would be based on use of hardware already procured, which would permit continued manned space operation until 1975. An option representing a severely constrained manned program would be continuation of manned flight following 1975 with Saturn V equipment. Procurement lead time would require a decision about 1972, and annual acquisition and operational cost for a minimal program of two launches per year would level out at about $1.2 billion. Such a program would be based on extended use of present technology and not allow any new development of equipment for manned flight during this time. Such a plan is not recommended, since we believe a continued vigorous manned program beyond this period will be important.

Competition with the USSR

The Apollo commitment had its origin in a crisis of confidence in the technological superiority of the U.S., with implications concerning our national security. While this situation has changed radically and we believe that the nation can plan its space program with considerable confidence and [9] detachment, our plans must reflect the concurrent Soviet activity.

The USSR continues to expand its investments in nonmilitary and military space operations. It seems to be actively preparing for a long-term program of manned space flight activity, including both manned lunar flights and extended manned flights in earth orbit. In addition, the Russians are in a particularly strong position to compete in unmanned planetary exploration—for which they have a well-tested rocket more suitable than ours—and they are steadily strengthening their nonmilitary applications programs.

Our response to Soviet space activity must insure that we do not abdicate unilateral capabilities to the USSR whose potential impact on our security cannot be readily assessed. Nor should we permit ourselves to be completely dependent on Soviet sources for major areas of important scientific information. In applications areas the U.S. should insure the strength of its commercial and national security positions and take the initiative in international space cooperation.

The task force also believes that continuation of a vigorous program of space exploration, involving man's participation, is desirable in order that the U.S. shall remain competitive in this most visible area of space activity, although we recognize this as more a political than a technical question.

These views have the following consequence in policy:

1. We should remain competitive in each of the following areas under the principles given above:

a. Manned and automated exploration of the solar system
b. Military and civilian space applications
c. Space science
d. Technology relevant to the above

[10] 2. There is no need for our space goals to mirror those of the USSR in detail; we can and should design a program to meet our needs.

3. Continued efforts should be devoted to the ultimate goal of cooperation with the Soviet Union in manned exploration of the solar system, in the order that this area of prestige competition might be reduced in cost and become a force for political accommodation.

4. Current NASA budget levels are sufficient to support an adequately competitive space effort.

Objectives and Scope of the Manned Space Program

The remarkable success of the Apollo 8 mission has provided renewed insight to the dramatic public appeal of manned space flight and bolsters our confidence that the manned

lunar landing may be accomplished as early as July 1969. With this convincing demonstration of our strength and capability in space technology we must examine and redefine the future role and objectives of manned space activity in our national space program. A decision regarding this role may be the most critical choice facing the new administration in regard to the space program.

The broad objectives of the space program, and particularly of its manned component, must be viewed realistically and objectively in two parts. The first part relates to the satisfaction of man's aspirations to explore his universe and extend his purview, coupled with the continued exercising of our national scientific, technological and industrial skill in a way that is dramatically appealing to the world public—a "show of constructive force," as it were. We will be measured, and we will measure ourselves against the Soviet Union by the quality and value of our space [11] activities, and thereby contribute to the over-all assessment of our relative strength and influence in the community of nations. Our accomplishments may further serve to provide an important domestic focus of national purpose and pride, a unifying and inspirational force of some consequence in the midst of difficult and divisive social problems.

The second class of objectives relates to man in space as a useful part of a scientific activity or a space applications operation. There are substantial differences of view among technically well-informed people about the future evolution of space technology, the role that man-in-space will play in it and how soon extensive practical use of man-in-space might come. Given a shirt-sleeve environment in which to work, men can probably work in the weightless state with an effectiveness nearly equivalent to their performance on the earth's surface. Doubts about the role of man in space arise in part from the rapid evolution of technology on earth toward the removal of man's intimate involvement in complex equipment and substitution of computer and other remote control systems. In part these doubts result from concern about risks to life that can never be reduced to zero. But primarily such doubts come from the great cost of placing man in orbit and sustaining him there with the necessary tools, propulsion, and other capabilities to be truly useful in a control or engineering role.

Whether these costs will be justified by the reductions in capital cost of space systems that manned operation, or manned repair and modernization in space might bring, and the value of man's dexterity in assisting with the assembly of complex systems in orbit will be to a large extent dependent on the total scale of space operations in the future and the reduction in costs of transport to orbit that new launch systems might bring. By this criterion [12] man cannot be said to "pay his way" in space today. There is a good reason to hope that in the long run man in earth orbit will be valuable in providing operational and engineering support to large-scale space operations and scientific experiments. Therefore, plans for future manned programs must recognize the fact that we do not know precisely what may be the proper or most useful functions of man in space, but it should be precisely our objective to find out.

It would be undesirable to define at this time a new goal that is both very ambitious in scope and highly restrictive in schedule, for example a manned landing on Mars before 1985, even though such a goal might be achievable. Such a commitment, adopted now, might inhabit our ability to establish a proper balance between the manned space program and the scientific and applications programs. On the other hand, there is probably some threshold budgetary level required to maintain a manned space flight capability in being, which may be between $1.2 and $2.0 billion per year. Some part of this manned space flight activity can be directed to the continued exploration of man's possible usefulness in space. The proposed Apollo Application Program, including the workshop experiments, will contribute to this end in the 1971-1972 period. Other than this program, the major focus of manned space flight during the coming half decade should be manned lunar exploration. It is inconceivable that we should terminate human exploration of the moon after one or two landings, with no activity beyond simply standing on the surface. However, continued manned exploration should be a thoughtfully integrated part of a total program of lunar exploration, utilizing unmanned landings and remotely controlled

exploratory devices when they are advantageous. The manned landing should be infrequent, but planned to extend progressively man's roll in the exploration.

[13] It should also be noted that achievement of prestige through space achievements may require some shift of emphasis from manned to unmanned activity. With our apparent momentary lead in manned flight, it is likely that Soviet programs will emphasize strongly a massive commanded and automated exploration of the planets. These two aspects of space prestige must be considered carefully.

In the continued investigation of man's proper roll in either space science or space applications, it is desirable to avoid undue polarization along manned versus unmanned flight and instead to focus on the search for the most appropriate roles for the human being in the entire system, on the ground as well as in space. The objective should be to devise the most efficient means of conducting the entire activity, with the human intelligence operating in the most effective location. The focus should be on the mission itself, and the mission-oriented plan should include, where appropriate, the determination of an optimum combination of manned and unmanned flights. The present organization of NASA is not at all adapted to this approach.

Programs and Priorities—Space Stations and Apollo Applications Program

The Apollo Applications Program should contribute to our understanding of man's utility in space, but needs a much closer connection than has been achieved so far with the space science and the space applications programs and a sounder foundation in biomedical research. For this, management must put strong emphasis on the missions to be accomplished. The "manned space station" concept, proposed as a program for the later 1970's, is on much more doubtful ground. It is much too ambitious to be consistent with the present clear needs for continued exploration of man's usefulness in space. [14] On the other hand, it is not obviously an effective way of continuing to demonstrate for prestige purposes our manned space capability. Perhaps the most unique function of a space station would be to test man's ability for an extended space flight over times of a year or more, so that the practicality of a manned planetary mission could be examined. Such a test would be needed by the mid-70's if a manned Mars mission by the early 80's were planned. However, the desirability of such a mission is not yet clear, and the Apollo Applications Program may be able to give useful partial answers to the possibility of very long-durations space flights. It therefore seems premature to make any firm program decision regarding the proposed manned space station.

Programs and Priorities—Lunar Exploration

The primary goal of manned space flight in the 1970's which should be planned now is the scientific exploration of the moon, by both equipment and occasional manned landings using upgraded versions of the present Apollo system. Alternatives for this choice are:

a. A commitment next year to a manned landing on Mars, which some of us believe could be carried out in the early or middle 1980's, if sufficient effort were made;

b. An earth orbital space station to house perhaps six to nine men who would make occasional trips to and from earth.

A great majority of the task force opposes a commitment to a manned Mars landing at this time. It believes that the space program in this second decade should not be built around a single monolithic goal on a fixed timetable. The task force also recognizes that a Mars landing in the early or middle [15] 1980's would require a substantial expansion of the NASA budget in the next few years. It proposes that the space station receive further study without a binding commitment until its design and purposes are more clearly delineated and the possibilities of a radical reduction in the future of costs of transportation to orbit are more firmly established. It appears that the AAP program for manned flight, also scheduled for the 70's, might serve many of the purposes of a space station.

Mixed manned and unmanned lunar exploration has the following advantages as a primary goal of manned spaceflight in the next 5-8 years:

1. Exploration of the moon may reveal surprises which our studies of the earth did not lead us to suspect. The resulting new concepts about the evolution of planetary systems may have far-reaching impact on our understanding of earth resources, earthquakes, and other matters of great importance to mankind.

2. Building on the capability provided by Apollo, it provides the best opportunity in the next ten years for utilizing man's unique capabilities in space exploration, having a high potential for sustained scientific and public interest.

3. Lunar exploration makes best use of the already contracted inventory of Apollo Saturn V launch vehicles, of which there are sufficient to carry such a program from about 1973 through 1976.

4. It exploits our current "lead" over the Russians, although we can expect manned landing on the moon by the USSR before we can prepare the needed lunar exploration capability, about 1973.

5. A combined manned and unmanned approach is not only one of minimum cost for the maximum return in scientific knowledge, it examines [16] both the competition and the synergism between systems in which the man is either at hand or in a remote location. In that sense we suspect it may be the forerunner of the space technology of the distant future.

This program will require adding vehicles for mobility on the lunar surface and also provision of longer stay time.

Programs and Priorities—
Use of Spacecraft and Associated Techniques for Civil or Commercial Benefit

Satellites give new and uniquely valuable capabilities. These capabilities can be exploited for the benefit of all society and for specific practical applications. For such exploitation an expanded program of research and development, using both ground-based and space techniques is needed.

Because of the high level of technical development and diversification in booster launch use, guidance and control, and durability of electronic equipment in space, recent technological developments have so increased the long life potential of satellites that their operational cost is greatly reduced and leverage for future great cost reduction is large. All this has laid the ground work for application of satellites in the fields of

1. Communications as a radio relay or repeater with high information capacity. Specific applications include public and commercial communications, for example, telephoning, T.V., data collection and transmission and navigation aids. These have only begun, with greater expansion expected when questions of national and international policy and of public and private interests are resolved.

[17] 2. Observation using the electromagnetic spectrum of reading the earth's resources and environment. Users, present and possible, include those in the fields of meteorology, agriculture, forestry, water resources, navigation and traffic control, geodesy and cartography and oceanography.

The opportunities for application in communication and observation are of such social impact on man and have such unrealized economic benefits that their support by NASA should be an immediate *major* program. NASA with the support of other government agencies should have a strong satellite applications program within government and which also encourages the private sector for development and investment.

Programs and Priorities—Planetary Exploration

We consider that unmanned planetary exploration should be a major component of the future space program of the Unites States.

There are nine major planets and an uncountable number of smaller, planet-like objects in the solar system, each of whose motion is dominated by the gravitational attraction of the sun. Each of the planets is a "new world." Each has its own special properties and no two are alike. The origin of the entire system and the separate histories of each planet form one of the most engaging puzzles of astronomical science. Much has been learned and much more can be learned by the use of ground-based optical and radar telescopes. But truly definitive study of the planets must await on-the-spot observations by fly-by, orbiting, and landed spacecraft. The pioneering Venus and Mars missions, Mariners II, IV and V of the United States and mission Venus IV of the USSR, have demonstrated the effectiveness of automated equipment for detailed investigations of the planets and have already yielded substantial advances in knowledge.

[18] The United States now possesses the technological capability and the scientific sophistication to send powerful automated spacecraft to Mars, Venus, Mercury, and the giant outer planet Jupiter within the next five years and to the most distant outer planets Saturn, Uranus, Neptune, and Pluto within the following decade. The first objectives will be to learn the physical properties of the planets—the composition, structure and temperature of their atmospheres; and nature and temperature of their surfaces; their precise shapes, masses and magnetic characteristics; and their internal structures as inferred from such evidence.

Following rapidly behind such physical investigations will be attempts to establish the existence or absence of extraterrestrial life. The discovery of any form of life on another planet would be an event of outstanding scientific importance and of profound cultural and philosophical significance.

It is our opinion that a vigorous program of direct planetary exploration by automated spacecraft is readily encompassed by our national resources and will greatly increase the scope and depth of human knowledge and perceptive.

Programs and Priorities—Astronomy and Other Sciences

Curiosity as to the origin, the fundamental nature, and the form of our physical universe is a subject of profound interest to all civilized man. The present prospects of carrying out experiments and making observations from the environment of space provides an opportunity for studying the nature of the universe in ways heretofore impossible.

Until the advent of flight above the earth's atmosphere we were able to view the physical universe with blurred vision and in only two narrow wavelengths regions out of broad system of radiation by which the [19] processes of the stars and galaxies manifest themselves. A satisfactory start in exploiting the clear seeing beyond the earth's atmosphere has been made; we can point with pride to the success of the Solar Observatories, the Astronomical Observatory, and a host of cosmic and X-ray experiments, where these early observations have revolutionized our picture of processes occurring in our Galaxy. These experiments are only the pioneer steps in space science and there are clear-cut, long-range goals in several areas which must be borne in mind in planning the continued science program from space.

In the area of galactic and extragalactic astronomy, it is important to provide means to see the universe in all available wavelengths and with the highest possible angular resolution. This requires the ultimate construction of high sensitivity, high directivity X-ray and gamma-ray facilities, radio telescope arrays of diameters of miles and a sophisticated optical telescope of diffraction limited performance comparable in size and versatility to the largest now existing on the earth. All of these goals are within the capabilities of our program and can be achieved within the next decade by a vigorous program of progressively more refined experiments, each scientifically justified in itself.

The closest star, our sun, reveals new phenomena and interactions with interplanetary medium as it is studied with increasing spatial and energy resolution and we must work toward more sophisticated observations of this object. The interaction of this source of energy with the material between the planets and the earth, and the manner in which

the cosmic rays are modulated as they enter the solar system is a subject of particular relevance to the astronomical and planetary programs of NASA.

[20] Furthermore, rather than looking at the moon and planets from a distance, we now have opportunities to view them at close range, and conduct experiments on their surfaces. The possibilities of studying the moon and planetary objects at first hand will vastly increase our understanding of geophysics and of the history of the earth and solar system.

Significance of the National Space Program to National Security

The national space program, taken as a whole, has been and will continue to be vital to national security. Certain parts of the program contribute very directly and with extremely high leverage to national security, while other parts make only an indirect and smaller contribution.

(The primary part of this section, which considers High Leverage Direct Contributions, is in a special classified appendix.)

Indirect Contributions of the Space Program to National Security

Indirect contributions of the space program to national security are important, but their naturally rather diffuse character makes it impractical to give more than a brief list of them here.

1. The national security, including in particular its diplomatic aspects, is substantially influenced by our apparent posture resulting from performance in the highly conspicuous areas of space science and technology, and space operations. Prestige factors are commented on in other sections of this report.

[21] 2. The space program and space-borne platforms have some unique potentials to help in a general way break down restrictions on free communications across borders and also to build healthy connections with other governments.

3. The space program provides challenging goals and severe tests of advanced technology and management techniques with are important to the nation's military effectiveness and economic success. Direct military programs and also some other civilian programs can provide a similar stimulus. However, the considerable human interest and the variety of new problems connected with the space program are notably effective in developing knowledge and trained personnel of importance to high technology and an adaptive military capability.

Reduction of Unit Costs of Space Operations

Much attention has been directed, particularly during the past six months, to the problem of achieving significantly lower costs in large boosters, without decrease in the reliability of the launching and boosting operations. It now seems clear that several different ways of achieving significantly lower launching and booster costs can be devised by taking full advantage of experience to date, and by applying current technology specifically to the purpose of reducing costs. The launching and booster costs per pound in low altitude orbit could be reduced by about a factor of 10—from $700-$1000 per pound to less then $100 per pound. (Enthusiasts suggest a reduction by a factor of 50.) This difference in cost could total many billions of dollars over a ten-year period. The exact savings depends, of course, on the number of launches one assumes. Each of the different [*ways*] [22] (recover both states, greatly simplified liquid propellant stages, and solid propellant stages) of accomplishing this reduction has its own vigorous proponents.

It does not appear necessary or desirable to initiate a major new program to achieve this cost reduction by any of the alternate approaches at this time. However, it is clear that continued priority should be given to the studies that are already under way, and that these

studies should be augmented to provide a more complete understanding of the technical alternatives, and to make more complete economic comparisons for several different future levels of launching activity, projected over the next fifteen years. This work should be focussed and coordinated by DOD and NASA so as to provide by about 1 November 1969 information upon which a joint DOD-NASA program decision could be made.

International Cooperation

The space program provides many opportunities, a variety of stimuli, and some necessity for new initiatives in international cooperation. Space beyond the earth's atmosphere, including the heavenly bodies, has generally been recognized as common to the human race. Satellites must of necessity cross national boundaries and the tracking or retrieving of them is likely to extend past national frontiers. Furthermore, they are generally much more efficient when used on a global scale. And the exploration of space, like human knowledge, is naturally an inspiration and an enterprise best shared by all men.

We believe that the present technological position and national interest in the U.S. make it desirable to take vigorous initiatives towards international cooperation in space work, and to continually make clear our earnest desire [23] for such cooperation.

In general our policy and programs for international space cooperation has so far been important but modest. Much broader cooperation with selected nations or groups of nations would be valuable and is strongly recommended. Cooperation in scientific experiments with Italy, Canada, France, West Germany, Great Britain, and several other countries has been so successful that it seems profitable to increase these types of projects with the hope that the cooperating countries would gain in competence and play a larger role. We do have agreements with the Soviet Union for exchanging meteorological and magnetic data. Satellite communications are rapidly moving into the area of international agreement (Intelsat).

Active study should be begun to seek and to analyze initiatives and policies for the U.S. which would further international cooperation in peace work. The first lunar landing may offer a particular occasion for useful and arresting moves.

Consideration should be given to the merits of an international laboratory financed and staffed by all participating nations in proportion to their interest and devoted to intensive study of world-wide systems such as global weather prediction, or an earth resources satellite system, or both. The U.S. would participate in, but not finance, this laboratory. The relationship of such laboratories to ESRO, WMO, and to the U.N. would require careful study. One could also consider regional laboratories such as in Latin America or Africa where the individual countries cooperating in the program could read out data from earth applications satellites and work up these data for their own areas.

[24] It is suggested that space cooperation with the Soviet Union in the near future take the form of planning and scientific collaboration rather than join conduct of space activities. The most promising area might be in unmanned planetary exploration—one in which Soviet competence matches our own, and with obvious savings to both countries. In the future this might be extended to lunar exploration.

Organizational Issues—Importance of a Civilian Organization

Separation of the space program into a part directed towards military applications in the DOD and a largely unclassified part without strong military coloring in NASA has, we believe, been an eminently wise policy. It is especially important to easy cooperation of foreign nationals and governments with NASA, and to the very friendly attitude towards NASA, its bases and operations, which characteristically occurs abroad. We recommend careful efforts to see that this part of the space program continues to be clearly separated from military applications.

Organizational Issues—DOD/NASA Interface

In considering the relationship between military and nonmilitary space programs, the first question which arises is: are the roles and missions of NASA and DOD in the national space program correctly established. We believe the answer to this question is generally "yes." That is, the DOD should continue its responsibility for all space programs directly supporting military missions and NASA should continue its responsibility for more general space and aeronautical science and technology, for applications of space technology to nonmilitary purposes (such as [25] civil communications, civil navigation and traffic control, weather prediction, earth resources surveys), and for general exploratory programs in the near earth, lunar, and planetary regimes. Whether programs are "manned" or "unmanned" it is not really fundamental to the division of missions between these agencies, and both NASA and DOD should employ men or not employ men in space as suited to their basic missions, and as influenced by the projects involved.

The next question which must be considered are: Are improvements necessary in coordination and mutual support between NASA and DOD programs, and are there significant opportunities for cost-savings in stronger central management of supporting capabilities, such as booster vehicles, launching vehicles, rangers, tracking and communications networks, recovery forces and operational centers? We believe the answer to both of these questions is also "yes." That is, significant steps *should* be taken to provide stronger policies on coordination and mutual support between NASA and DOD programs, stronger central management and control of major new program planning and initiation, and stronger and more cost-sensitive management of supporting capabilities. These improvements are particularly needed relative to potential new manned space flight programs with potentially large budgetary impact.

This problem is complicated and requires mature, thorough, and objective study. Certainly no major changes in responsibilities or organizational reporting relationships should be introduced in the Apollo program prior to the lunar landing. In general, transfers of major organizational units and facilities between agencies may not be needed, if strong machinery or central coordination and management on a national basis can be effected, with suitable directed mutual support.

[26] We suggest that the new Secretary of Defense and the new Administrator of NASA be directed by the President to present specific recommendations aimed at these objectives.

Organizational Issues—Internal Organization of NASA

The present internal organization of NASA is oriented toward the achievement of a manned lunar landing by 1970, with manned and unmanned operations administratively divided. The organization is complex, often with no clear distinction between line and staff functions, and is considered inappropriate for the problems of the post-Apollo space program. While the present structure should not be seriously disturbed before the first lunar landing to avoid any possibility of interfering with this operation, after Apollo the administrative organization of NASA should be changed to correspond to program objectives rather than means of accomplishing them.

In the area of applications, NASA should be encouraged to continue its technical and scientific program leadership. This should continue beyond the initial research and engineering development stages into pilot operations. NASA should continue responsibility for total space flight experimental systems—that is, satellites, sensors, ground stations, test sites, and data processing. User agencies should participate actively in planning and in evaluating results, and in the establishment of budgetary controls. NASA should be organized to work in close cooperation with potential users, especially at the administrative and middle management level. Only thus, through shared responsibility, can the potential benefit of future operations be understood by those concerned, and programs designed for maximum efficiency and benefit.

[27] We believe that future scientific and applications returns from NASA investments can be substantially improved by strengthened policy and managerial direction. There are a number of ways this might be achieved, but one possibility is the return to a feature of the management structure under President Eisenhower: policy leadership is provided by an Administrator and his Deputy, one of whom should be an experienced executive with the primary political responsibility, the other a distinguished and internationally recognized scientist. Policy would be executed by a General Manager.

Legislation

New legislation relating to the space program may be required or appropriate during the next session of Congress in the following areas:

1. National Aeronautics and Space Council

The National Aeronautics and Space Council was established by the organic Act of Congress which created NASA (the National Aeronautics and Space Act of 1958), as a permanent mechanism for resolving policy differences and coordinating operations, primarily between the civilian and military space programs. The original Act provided for the President to be Chairman of the Council. This provision was later amended so as to substitute the Vice President (then Lyndon Johnson) as Chairman.

Although the new President will have the option of asking Congress to abolish the Council, or of not calling any meetings, we believe that as long as the Council exists and is used it should be made effective. For that purpose, there should be a strong staff and the President should be the Chairman. The later will require new legislation.

[28] 2. Communications

The capabilities and current use of satellites for communications purposes point to major imminent changes requiring legislation. For example, satellites can be used for communications within the United States. A proposal has been made to the Johnson Administration, by a task force on communications, to consolidate all U.S. international telecommunications into a single organization. We recommend early study of what legislation is needed in this area.

3. Rights to Inventions

The patent provisions of the National Aeronautics and Space Act are modeled on those of the Atomic Energy Act, and therefore differ radically from other laws governing rights to inventions made under similar circumstances. As the Act is now administered, title to inventions made under defined circumstances is vested in the Government unless the Administrator affirmatively determines that it should be vested in the inventor. We recommend that this emphasis be reversed.

Spencer M. Beresford
Lewis M. Branscomb
Francis H. Clauser
Harry H. Hess
Norman H. Horowitz
Samuel Lenher
Ruben F. Mettler
Charles R. O'Dell
Allen E. Puckett
Walter O. Roberts
Robert Seamans
Charles H. Townes (Chairman)
James A. Van Allen

January 10, 1969
Dr. Charles Townes, Chairman
Task Force on Space

Dear Charles:

In this letter I should like to present a view about the future of the U.S. space program that is somewhat divergent from the report of our task force. The space program is now rising to the climax of placing men on the moon. The world is acclaiming this an event which may herald a dawn of an age of exploration.

Mr. Nixon faces the task of planning the nation's future in space. He needs from us an assessment of the technological development that is possible. In our report I believe we have painted a picture which underestimates the potentialities of the future. In predicting progress today's problems loom large and tend to overshadow the inevitability of future development. My experience would indicate that the ingenuity of mankind can be relied upon to overcome today's obstacles and to carry us upward at an ever-accelerating rate.

Instinctively I feel if Mr. Nixon were to chart a bold program for us to explore the solar system and to push ahead with space science and applications, U.S. technology would be able to meet such a challenge. I think our rate of development can be considerably more rapid than presented in the task force report. For example, I believe we can place men on Mars before 1980. At the same time we can develop economical space transportation which will permit extensive exploration of the moon and in an even shorter time we can place large telescopes in orbit.

Whether we embark on such a space program is a decision that Mr. Nixon and the American people must make, balancing cost against historical perspective. I simply take this opportunity to record my views that as a nation we are capable of carrying through on such a challenge.

Cordially yours,
Francis H. Clauser

Professor Clauser has asked that the above view be submitted with the Task Force Report.

I associate myself with this minority view in believing the tone of the report does not reflect very well the real technical potentials of the longer range, nor the imperatives of that peculiar species, man. However, I endorse the report's conclusions and recommended present actions.

Charles H. Townes

Document III-22

Document title: Richard Nixon, Memorandum for the Vice President, the Secretary of Defense, the Acting Administrator, NASA, and the Science Adviser, February 13, 1969.

Source: NASA Historical Reference Collection, History Office, NASA Headquarters, Washington, D.C.

As the Nixon administration took office on January 20, 1969, it was clear to all that decisions with respect to the goals and pace of the space program after the first lunar landing needed to be made, and that some sort of review would be the first step toward such decisions. The new science adviser, Lee DuBridge, at first attempted to have the review carried out under his direction. DuBridge, who as president of the California Institute of Technology during the 1960s had clashed with NASA Administrator Webb, was thought to share the scientific community's skepticism regarding the value of human space-

flight. Thus NASA let it be known to the White House that it was opposed to DuBridge as the chair of the proposed space review.

By this memorandum, President Nixon established a Space Task Group, chaired by Vice President Spiro T. Agnew, to conduct the review. Agnew was chosen because he was by law the chairman of the National Aeronautics and Space Council. That council had fallen into disuse during the latter years of the Johnson administration, and the White House chose to assign the responsibility of staff support for the review to DuBridge and his staff in the Office of Science and Technology.

Memorandum for

The Vice President
The Secretary of Defense
The Acting Administrator, National Aeronautics and Space Administration
The Science Adviser

It is necessary for me to have in the near future definitive recommendation on the direction which the U. S. space program should take in the post Apollo period. I, therefore, ask the Secretary of Defense, the Acting Administrator of NASA, and the Science Adviser each to develop proposed plans and to meet together as a task group, with the Vice President in the chair, to prepare for me a coordinated program and budget proposal. In developing your proposed plans, you may wish to seek advice from the scientific, engineering, and industrial communities, from The Congress and the public. You will wish also to consult the Department of State (on international implications and cooperation) and other interested agencies, as appropriate, such as the Departments of Interior, Commerce, and Agriculture; the Atomic Energy Commission, and the National Science Foundation. I am asking the Science Adviser also to serve as staff officer for this task group and as coordinator of the staff studies.

I would like to receive the coordinated proposal by September 1, 1969.

Richard Nixon

Document III-23

Document title: T.O. Paine, Acting Administrator, NASA, Memorandum for the President, "Problems and Opportunities in Manned Space Flight," February 26, 1969.

Source: NASA Historical Reference Collection, History Office, NASA Headquarters, Washington, D.C.

The creation of a Space Task Group external to NASA as the means for reaching post-Apollo decisions was not totally welcomed by NASA. Unlike his predecessor James Webb, NASA Acting Administrator Thomas Paine preferred that the space agency decide internally what its priorities were and then seek support for them from the White House and Congress. NASA Headquarters had begun a long-range planning process in early 1968, and the various NASA field centers, particularly the Manned Spacecraft Center in Houston, had also been thinking about future programs as they worked on current programs.

By early 1969, NASA had identified a large, permanently occupied space station as its top-priority post-Apollo objective. Hoping to bypass the deliberations of the Space Task

Group and to get an early endorsement of such an undertaking, Thomas Paine went directly to the president with a carefully crafted case for such an action. The White House quickly rebuffed Paine's initiative, telling NASA that any decisions on future programs would await the recommendations of the Space Task Group.

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[1] This memorandum is the first of several that I am preparing in response to your request of February 17, 1969, that I give you my views on the principal policy problems in space and aeronautics which now face your Administration, point out some of the opportunities for leadership initiatives now open to you, and give you my recommendations on the new directions which your Administration should set for the nation in space and aeronautics. These memoranda will also serve to indicate the alternative approaches NASA is examining in developing plans and proposals for the post-Apollo period as requested in your memorandum of February 13, 1969, and the basis for my recent recommendations to the Director of the Budget on amendments to the NASA FY 1970 Budget. Copies are being sent to the Vice President, the Secretary of Defense, and your Science Advisor as you requested, with additional copies to the Director of the Budget and Mr. Robert Ellsworth.

This memorandum outlines the problems, opportunities, and principal factors to be considered in *Manned Space Flight*, the area in our space program where NASA and your Administration are faced with the most urgent need for high-level decisions.

1. **Introduction** — NASA now has no approved plans or programs for manned space flight programs beyond the first Apollo manned lunar landings and the limited Apollo Applications earth orbital program now approved and underway. Sharply reduced space budgets over the past three years and the failure of the previous Administration to make the required decisions and provide the necessary resources for future programs have built in a period of low accomplishment which will become apparent during your Administration, and have left the program without a clear sense of future direction for the post-Apollo period. Positive and timely action must be taken by your Administration now to prevent the nation's programs in manned space flight from slowing to a halt in 1972.

The Apollo program served the nation well in providing a clear focus for the initial development and demonstration of manned space flight capabilities and technology. What is needed now, however, is a more balanced program for the next decade which will focus not on a single event but on sustained development and use of manned space [2] flight over a period of years. As discussed below, there are two principal program opportunities: one is a long-term carefully-planned program of manned exploration of the moon, the other is a wide range of activities involved in the progressive development and operation of a permanent manned station in earth orbit. I believe that (a) manned lunar exploration should be continued at an economical rate to the point where a sound decision on the future course the nation should follow with respect to the moon can be made on the basis of knowledge and experience gained from a series of manned missions, and (b) the nation should, in any case, focus our manned space flight program for the next decade on the development and operation of a permanent space station—a National Research Center in earth orbit—accessible at reasonable cost to experts in many disciplines who can conduct investigations and operations in space which cannot be effectively carried out on earth.

2. **Status of U.S. Programs and Plans** — If our Apollo flights continue to be successful we will achieve the first manned lunar landing later this year, possibly as early as this summer. We will then carry out three additional landings at different locations on the moon, but the improved equipment required for moving beyond this with a scientifically significant lunar exploration plan is restricted to the study stage. We will have a number of Saturn V boosters and Apollo spacecraft for future lunar missions left over from the Apollo program.

In earth orbit, the next major U.S. milestone is manned space flight is the Saturn I Workshop, which is now scheduled for launch in late 1971. This first step toward a space station will use existing Saturn IB rockets left over from the Apollo Program. Flight operations, including revisit and experimental Apollo telescope operations, will be completed in 1972. The military missions of the Air Force's smaller and more specialized Manned Orbiting Laboratory (MOL) are expected to take place about the same time.

There are no approved plans and no provision in the FY 1970 Budget for continued U.S. development or utilization of manned space flight beyond the Apollo moon flights, the single set of Saturn I Workshop and Apollo telescope missions, and the Air Force MOL program as currently planned. For the future of manned space flight beyond 1972 the present FY 1970 NASA Budget provides only small sums limited to studies of advanced manned lunar exploration and earth orbital space stations.

3. **USSR Prospects** — Recent USSR manned space flight activities substantiate previous indications that they are continuing strong programs pointed both at manned operations to the moon and at space station operations in earth orbit. Beyond this, they talk openly of future manned trips to the planets. While we now expect to land American astronauts on the moon before the Russians get there, the prospects are that during the period of our lunar flights in 1969-1970 the Soviets will, in addition to their manned lunar program, follow up their Soyuz 4-5 [3] success by pushing toward a dominant position in large-scale long-duration space station operations in earth orbit. They will have the required heavy-lift launch capability. A multi-man, multi-purpose USSR space station operating in orbit before the U.S. could match it would give the USSR a strong advantage in space research and operations. Their moving clearly ahead of the U.S. in this field would have a continuing impact on the rest of the world, particularly if the U.S. program did not include a strong program in the earth orbital space station area.

4. **Opportunity for Leadership** — The fact that the previous Administration deferred to you the setting of the nation's goals in manned space flight creates a problem, but it also gives you a unique opportunity for leadership that will clearly identify your Administration with the establishment of the nation's major goals in manned space flight for the next decade. The impact and positive image of your leadership would be seriously downgraded in the eyes of the nation, the Congress, and the public, in my view, if the U.S. were once again placed in the position of reacting to Soviet initiatives in space. For this reason, I believe that you should consider the advisability of initiating a general directive to define the future goals of manned space flight in the next few months, prior to your final decisions on the plans that will be recommended to you on September 1 by the members of the Task Group you have established. For example, a major thrust this summer by the USSR in the earth orbital space station field is a distinct possibility that would take the edge off your announcement of a similar U.S. objective in the fall. For the reasons given below, I believe that the case that a space station should be a major future U.S. goal is now strong enough to justify at least a general statement on your part that this will be one of our goals, with the understanding (which could be reaffirmed in your statement) that the scope, pace, specific uses, and detailed plans of the space station will be determined on the basis of the planning studies you have requested.

5. **Basic National Policy** — There is, I believe, almost unanimous agreement on the part of responsible leaders in your Administration, the Congress, industry, the scientific community, and the general public that the U.S. must continue manned space flight activities. The concerns and criticisms that have been expressed do not question the continuation of a manned space flight program but relate principally to (a) the cost of the program, (b) the value of specific goals, and (c) questions of priorities, within the space program or between the space program and other scientific fields or other national needs. However, virtually no responsible and thoughtful person, to my knowledge, advocates or is prepared to accept the prospect of the United States abandoning manned space flight to the Soviets to develop and exploit as they see fit.

It is very important that all concerned with planning the [4] future of our space programs recognize this basic question of national policy. Acceptance of the fact that as a

matter of policy the nation must and will continue in manned space flight leads to the following four points which should be considered in our planning:

a. Studies of our alternatives in future space programs should focus on *pace, objectives, and content* of the manned space flight program, not on whether the U.S. should have a manned program. Alternatives which have the effect of not supporting a continuing effective U.S. manned flight program are not acceptable. A balanced total space program must include a significant continuing manned space flight program as one of its key elements.

b. The U.S. must be prepared to pay the annual cost of an advancing, effective manned space flight program, high though it may seem. An important early objective, however, must be to reduce the cost of manned space flight, without sacrificing safety, reliability, or accomplishment.

c. An advancing, effective manned space flight program cannot at this stage be limited to repetitive flights of missions already flown but must provide for the continuous evolutionary development of new capabilities, new missions, new experiments, and new applications.

d. Decisions and selections of future programs must be made on a continuing timely basis several years *before* current objectives are achieved; otherwise the long lead-times inherent in the space program will force dangerous and expensive breaks in continuity that will undermine the success of the program.

5. **Effects of Decisions in the Previous Administration** — The failure, during the past three years, to make timely decisions and to take necessary future-oriented actions has placed our manned space flight program in a serious and difficult position for the early 1970's. The production of both Saturn IB and V launch vehicles has been terminated. The Saturn V vehicles now on order must either be launched on schedules stretched out to clearly uneconomical rates, rates which may be below the minimum acceptable for reliability and safety, or flown with experimental payloads that repeat previous missions without significant advances. The failure to develop and approve future goals and objectives has forced the program into expensive and unproductive "holding" operations in some areas and made it more difficult to focus sharply on the planning and preliminary development efforts which must precede future programs. The watchwords of budgetary actions for the past several years have [5] been "delay," "stretch-out," "defer," and "hold the options open." The results are that for the next several years the nation will be getting a smaller return on its great investment in manned space flight capability, and that the long-deferred decisions on future goals must be taken now at an earlier time than your Administration would otherwise prefer.

6. **Recommended Approach** — I believe that your Administration should now speak out boldly about the nation's future in space. Instead of continuing to stretch out and *minimize* the manned space flight program at the risk of reducing it beyond the point where it can be effective, your Administration should (a) point out the fact that the nation must continue to move forward in manned space flight, (b) while seeking every economy, accept the costs that this entails, and (c) plan, announce, and support a new ten-year space program—including a strong program of manned space flight—of which this nation and the world will be proud. Your Administration's decisions in the next few months will determine the nation's direction and progress in space for many years.

7. **Study of Future Directions** — The process established in your memorandum of February 13, 1969, provides a useful framework for the development of specific goals and plans for the future of our space program. It will, among other things, enable NASA to communicate to the other agencies involved the thinking and planning that we have had underway for some time, and help assure NASA that its planning is properly coordinated with future aerospace planning in DOD, DOT, and other departments.

However, unless adequate provision is made in the FY 1970 Budget in time for Congressional action in the FY 1970 authorization and appropriation cycle, the implementation of plans decided upon next fall as a result of the Task Group recommendations will have to await the FY 1971 cycle. This would mean the loss of an entire year and the

foreclosure of your option to move ahead promptly with a strong manned space flight program if that should be your decision.

For this reason, I believe that it is essential that the FY 1970 Budget be amended now to include the manned space flight funds—specifically deleted by the previous Administration—required to support moving ahead in lunar exploration and space station development. I can appreciate that you may be reluctant to decide now to amend the FY 1970 Budget, thus appearing to prejudge the recommendations to be made in September, but postponement will foreclose what may well be your most attractive option and will perpetuate and aggravate an already unsatisfactory situation.

8. **Future Directions and Goals** — As stated above, two major directions have been identified for the manned space flight [6] program in the next decade. One is the further exploration of the moon, with possibly the eventual goal of establishing a U.S. Lunar base; the other is the further development of manned flight in earth orbit, with the goal of establishing a permanent manned space station in earth orbit that will be accessible and useful for a wide range of scientific, engineering, and application purposes. An important part of the space station goal is the development of a low cost logistics system for shuttling people and equipment to and from the space station.

These goals have in common the fact that they are not focused on a single dramatic achievement to be accomplished by a certain date, as was the case in the Apollo program. However, they can provide in the second decade of space, as Apollo did in the first, the focus for continuing advances in U.S. space capabilities and technology which will be available to support future defense and civilian requirements and to sustain our long-term national technical and economic vitality.

9. **Lunar Exploration** — In lunar exploration, our immediate problem is to assure that we have adequate scientific and operational equipment to allow us to follow up the first few lunar landings with an effective initial program of exploration that will permit sound judgments on the potential value of more advanced future missions and the eventual establishment of a lunar base. If, as we now expect, we have early success in achieving the first manned landing on the moon, we will have Apollo hardware—launch vehicles and spacecraft—for as many as nine additional lunar missions, but we lack scientific and improved operational equipment for more than three of these. In order to proceed with these missions at an economical rate, we are preparing a budget amendment that will permit prompt initiation of procurement of additional scientific and operational equipment early in FY 1970. Your approval of this budget amendment now will not constitute a commitment to lunar exploration beyond that possible with the Saturn-Apollo hardware procured for the Apollo program. Decisions on an advanced program of lunar exploration requiring major redesign of the Apollo Lunar Module, the development of shelters and vehicles for use on the lunar surface, and the question of the ultimate goal of establishing a lunar base can and should be made in your review of the plans and proposals to be submitted next September.

10. **Space Station** — With respect to future manned earth orbital flight, the immediate problem is to assure that sufficient funds are available in FY 1970 to permit detailed planning and design studies to proceed, and to develop critical long lead-time subsystems that will be required in any future manned space flight program. Funds for these purposes were specifically excluded from the present FY 1970 Budget, except for a small amount for studies, and we are therefore preparing an appropriate amendment to the FY 1970 Budget. This budget [7] amendment can be approved now without a commitment on your part to a permanent space station as a major national goal. However, as stated in paragraph 4 above, we believe that it is in the national interest for you to endorse this as a general U.S. objective at this time. One possibility would be for you to give NASA and the Task Group a specific instruction at the time you approve the budget amendment that their recommendations to you in September should include proposals on the optimum program for establishing and utilizing a permanent U.S. space station.

11. **Space Station Concept** — The space station discussed here should become a central point for many activities in space and would be designed to carry on these activities

in an effective and economic manner. It would be located in the most advantageous position to conduct investigations and operations in the space environment, many important aspects of which cannot be duplicated in an earth-based environment. The best place to study space is in space. We have in mind a system consisting of general and special-purpose modules with a low-cost logistic support system that will permit ready access and return by many users and their equipment and supplies. The space station would not be launched as a single unit, but would evolve over a period of years by adding to a core new modules as they are required and developed. One of the key objectives is to develop the system in cooperation with the Department of Defense so that it can be adaptable for future military research as well as for a variety of non-military scientific, engineering, and other application purposes.

There are many potential valuable uses of such a space station, and new ones will be found as experts in many fields become familiar with the possibilities and are able to visit and actually use it. However, we believe strongly that the justification for proceeding now with this major project as a national goal does not, and should not be made to depend on the specific contributions that can be foreseen today in particular scientific fields like astronomy or high energy physics, in particular economic applications, such as earth resources surveys, or in specific defense needs. Rather, the justification for the space station is that it is clearly the next major evolutionary step in man's experimentation, conquest, and use of space. The development of man's capability to live and work economically and effectively in space for long periods of time is an essential prerequisite not only for operations in earth orbit, but for long stay times on the moon and in the distant future, manned travel to the planets. It is for these reasons that I believe that space station development should become one of your Administration's principal working goals for the action over the next decade.

12. **Saturn V Production** — Under NASA's reduced 1969 operating plan and its present FY 1970 Budget, the production of [8] Saturn V, the nation's largest launch vehicle, has been discontinued. The long-term future of the manned space flight program, as outlined above, will clearly require additional Saturn V launch vehicles, and we are therefore proposing a FY 1970 Budget amendment which will permit production to be resumed, at a very low rate, before "start up" costs become excessive. This amendment will not preclude other future decisions on large launch vehicles that might be made next fall, but it will assure that funds are available to provide the launch vehicles that will be needed. It will also get the U.S. out of what I believe to be a current untenable position of having discontinued production of our largest space booster at a time when the Soviets are expected to unveil a booster of this class or larger. For the reasons stated in paragraph 4 above, I recommend that you now take the initiative and announce this decision before the Russians launch their first booster in this class, so that your announcement will not be viewed as a reaction to the Soviet development.

13. **Cost** — In planning the space program careful consideration must, of course, be given each year, and especially at the time new major programs are undertaken, to the future budget levels required. Our national budget system wisely and necessarily provides for a review at least annually of both on-going and new programs, but long-term enterprises like major space programs require a policy commitment to follow through with the resources required over a period of many years. For these reasons, it is important that your Administration be prepared to accept the total budget levels required by the programs you determine to be in the national interest. NASA on its part has the obligation continually to search out the least costly ways of carrying out the approved programs and to make every effort to use the possibilities of new technology to reduce future costs. But most important of all, neither NASA nor the Administration should, in the name of economy, underestimate the resources that can realistically be expected to be required. We must meet our commitments.

Our present projections indicate that a balanced total NASA program that includes the recommended strong manned space flight program can be carried out with annual budgets over the next five years which will not rise above the $4.5 to $5.5 billion range.

More precise projections will depend on the nature of the future lunar exploration and space station programs decided upon and on future decisions in areas other than manned space flight. By the time we submit the planning proposals to you in September we will be able to state with considerable confidence the projected future estimated costs of alternative total programs.

A total annual program level of $4.5 - $5.5 billion compares to program and expenditure levels in the $5.0 - $6.0 billion range reached in the 1964-1967 period, which in the past two years has been reduced to $3.9 billion in our FY 1969 operating [9] plan and the present FY 1970 Budget. As we have informed the Director of the Budget, the FY 1970 NASA Budget amendments we are proposing in manned space flight amount to about $200 million and would bring our total 1970 Budget (including authority carried forward from FY 1969) to slightly under $4.1 billion. Even with this proposed amendment, however, NASA's outlays (expenditures) in FY 1970 will still decline $200 million from the $4.25 estimated for FY 1969.

This memorandum has given you my recommendation on the position your Administration should take with respect to the critical and urgent situation in manned space flight; other NASA problems and opportunities can be treated appropriately in the Task Group framework for your consideration in September. For the reasons stated above, and with the possibility of an initial lunar landing in July, I believe you should not defer initial consideration of the manned space flight problem. I therefore specifically recommend that you ask the members of the Task Group established in your memorandum of February 13, 1969, to meet within the next month and to consider as their first order of business the matters identified in this memorandum as requiring your early decision. They should then present their recommendations to you by the end of March. In anticipation of such a meeting, NASA will prepare and make available to the other members of the Task Group (a) detailed materials on the alternatives available, and (b) suggestions on how the recommended early decisions can be related to an effective process for developing overall space plans and alternatives for your consideration in September. I hope that this proposal will meet with your approval, and would, of course, be happy to discuss this matter further with you at your convenience.

T.O. Paine
Acting Administrator

Document III-24

Document title: Robert C. Seamans, Jr., Secretary of the Air Force, to Honorable Spiro T. Agnew, Vice President, August 4, 1969.

Source: NASA Historical Reference Collection, History Office, NASA Headquarters, Washington, D.C.

Robert Seamans had been NASA Associate Administrator and then Deputy Administrator during most of the 1960s, and returned to Washington to become Richard Nixon's Secretary of the Air Force. Given his background and the central role of the Air Force in military space, Secretary of Defense Melvin Laird asked Seamans to serve in his stead as the Department of Defense representative on the Space Task Group.

In the days following the July 20 landing of the Apollo 11 mission on the Moon, NASA decided to propose to the Space Task Group an ambitious program for the future, oriented to early human missions to Mars. Vice President Agnew supported such an initiative, and NASA scheduled an elaborate presentation of its proposals for August 4. Troubled by the direction that the Space Task Group deliberations were taking, Seamans came to the August 4 meeting with this letter, expressing a much more measured outlook for the next steps in space.

[1]
Dear Mr. Vice President:

The Department of Defense has carried out a comprehensive study of the various opportunities for using space technology to enhance national security. Options for increased space activity have been carefully reviewed by the Services, the Joint Chiefs, and the offices of the Secretary of Defense, and are the basis for a report that is being transmitted to you by Secretary Laird. As a member of your Space Task Group, I am writing this letter to give you certain of my own personal views.

Rocketry and advanced electronics have permitted us to accomplish unique missions in this decade. The landing of the Apollo 11 astronauts on the moon and their safe return to earth is the crowning achievement. However, NASA and DoD have accomplished many other highly significant missions that are important for scientific, technical and operational reasons. As a result of unmanned and manned space flight we know a great deal more about the sun, the moon, the earth, and our sister planets. We are developing a better understanding of meteorology, and are using satellites for communications, navigation, weather forecasting, mapping and surveillance. With this as background, let me outline a space program that I believe is relevant to our national needs. This program can provide focus in the next decade similar to that of Apollo in this decade, but with several rather than a single objective.

1. **Direct Service to Mankind**

We should capitalize on NASA's great scientific and technical capability to the maximum extent possible. By this I mean that NASA should wherever possible carry out work of direct relevance to man here on earth. ESSA of the Department of Commerce needs assistance to understand and predict the weather more accurately for longer periods of time. The Department of Commerce, Interior, and Agriculture need support that can be supplied by satellites if they are to carry out their responsibilities in such fields as oceanography, hydrology, [2] agriculture, ecology, etc. However, I am not only thinking of further satellite developments, but also the use of NASA's capability wherever pertinent to current national problems.

NASA should put increased emphasis in aeronautics. We, in the Department of Defense, have need for greater effort by NASA to support us in the development of military aircraft. The Department of Transportation needs major support if they are to implement a new air traffic control system.

The extent to which NASA can support HUD and HEW has not been determined, but it should be noted that advances in space are dependent upon extensive data processing. Data processing is required in cities for a wide variety of purposes, including traffic control, crime detection, communications and administration. Space exploration also requires in-depth investigation of waste management, fire prevention, materials development, construction of highly reliable equipment, all of vital importance to municipalities.

The medical and biological investigations of man in space have led to improved biological instrumentation, and a better understanding of physiology.

The applications of the NASA program are far reaching and considerably more effort should be expended to make the results available for the benefit of mankind. To accomplish this objective, program priorities will have to be revised and organizational changes will have to be made both internal to NASA and between NASA and other agencies.

2. **National Security**

As stressed in the Department of Defense report, space is an environment that provides many opportunities to improve and support military operations. These opportunities include improvements in communications, weather forecasting, navigation, surveillance, mapping and many others areas, all of which are discussed at length in the DoD report. However, from the standpoint of the Department of Defense, space exploration and the development of space technology are not ends in themselves, but rather provide

means for accomplishing functions in support [3] of existing forces. *Each military space mission must be approved on a case-by-case basis and weighed carefully against other means for doing the same job.* In the DoD report, a program is defined that maintains the annual outlay at about its present level. However, options exist that would require an increase in annual outlay by about 50%. In any event major effort is required to improve DoD space capabilities by development of advanced systems with greater sensitivity, invulnerability, and longer on-orbit life time.

3. **Extended Lunar Exploration Using Apollo**

The objective of Apollo was to provide a manned transportation system from earth to the moon and return. From Apollo 11 we will derive significant scientific information, particularly by analysis of the lunar samples. Now that the lunar transportation system exists, we should use it for a continuing series of missions with the principal objective being to derive maximum scientific data from the moon. This will entail landing on different areas of the moon in order to bring back different materials and in order to implant a wide variety of instruments. To do this effectively, some additional mobility will be required for the astronauts on the lunar surface. *In a continuing manned lunar landing program it is important to proceed on a careful step-by-step basis reviewing scientific information from one flight before going to the next and using unmanned spacecraft where appropriate.*

4. **Applications of Apollo to Earth Orbital Missions**

The Apollo hardware can also be used for further exploration in earth orbit. The objectives here include the involvement of man for extended periods in earth orbit both to better understand man's performance in extended flight, and also to use man to make a wide variety of measurements both of the earth, of the immediate space environment, and of the sun and the stars. *The present Apollo Applications Program including relatively few missions should be expanded to include longer duration flights and wider variety of orbits.*

5. **Space Transportation**

The extent to which space is used either for exploration or national security depends upon the cost per pound in [4] orbit. Today's flights are expensive because most of the hardware is lost and even that which is returned cannot be readily and inexpensively repaired for additional missions. *I recommend that we embark on a program to study by experimental means including orbital tests the possibility of a Space Transportation System that would permit the cost per pound in orbit to be reduced by a substantial factor (ten times or more).* Although preliminary studies have been conducted by both the Department of Defense and NASA on new types of space transportation, it is not yet clear that we have the technology to make such a major improvement. Consequently, I believe we should not put a rigid time constraint on this objective, but rather embark on a flexible program where various alternatives are investigated. Then at a later date, if the decision is made to proceed with an operational system, it can be made with technical, funding, and schedule confidence.

6. **Manned Space Station**

Multi-manned space stations have been studied and evaluated for many years. The specific objectives for a space station are still not clear even though a large number of interesting possibilities have been suggested. I believe that ultimately a space station will be needed where man can live and work for long periods of time (a year or more), and where no special astronaut type training is required prior to a mission. This will permit scientific personnel to concentrate entirely on their specialties and to carry out projects where a space environment is required.

Even though the development of a large manned space station appears to be a logical step leading to further use and understanding of the space environment, I do not believe we should commit ourselves to the development of such a space station at this time. I believe that we should wait until we have had further experience with the Apollo Applications Program and a Space Transportation System before we embark on this mission. Knowledge derived from Apollo

Applications will give us a much greater understanding of the role that man can perform in space and only after a thorough investigation of a Space Transportation System can we predict with reasonable accuracy our ability to resupply such a station economically and to ferry astronauts, scientists, and engineers back and forth from earth to the space platform.

[5] 7. **Planetary Missions**

We are rapidly acquiring knowledge of Mars and Venus, the two closest planets, using unmanned spacecraft. *The unmanned planetary program should be expanded to include more thorough investigation of Mars and Venus, as well as exploration of the more distant planets.*

I don't believe we should commit this Nation to a manned planetary mission, at least until the feasibility and need are more firmly established. Experience must be gained in an orbiting space station before manned planetary missions can be planned. At this time we do not know the effect of placing a man in space for the one to two years required for a planetary trip. There may be serious physiological and psychological effects that must be understood and dealt with before such a trip can be considered a possibility.

A decision to travel to Mars, the only accessible planet, would require new launch vehicle stages and spacecraft modules and a greatly increased annual outlay that would compete with the resources needed to provide immediate benefits from NASA's capability.

In summary, the Department of Defense must use space to enhance its capability as appropriate to its various responsibilities. The NASA program, on the other hand, should continue to explore space with both unmanned and manned spacecraft, but with the solution of problems directly affecting man here on earth as its immediate objective. In the past, there has been much discussion as to whether NASA had the right balance between unmanned and manned flights and between science and technology. I believe that in the future the balance of NASA's activities should be shifted not from considerations of manned vs. unmanned flights nor from considerations of science vs. technology, but from considerations of how this highly trained, highly motivated agency can make this country and the world a more hopeful, and healthier place. Let us take the initiative and use the good will, the momentum and the skills demonstrated in Apollo to help solve many of our problems at home and abroad. But let us not give up exploration, rather let us also continue our exploration while validating its benefit to all mankind.

Respectfully,
Robert C. Seamans, Jr.

Document III-25

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Source: NASA Historical Reference Collection, History Office, NASA Headquarters, Washington, D.C.

The report of the Space Task Group was presented to President Nixon on September 15, 1969. The report largely endorsed the hardware elements of the program that NASA had developed in the weeks following Apollo 11, including the development of a space station and a reusable transportation system. The Space Task Group as a whole did not recommend any particular option, though both the vice president and NASA Administrator Paine within a few days urged the president to approve Option II, which called for station and shuttle development by 1977 and an initial Mars expedition by 1986. In the days immediately preceding delivery of the report to the president, senior White House staff had demanded that the language of the report be changed so that the president not be put in the position of having only ambitious options from which to choose; thus the

tone of the "Conclusions and Recommendations" section of the report is not consistent with the content of most of the rest of the document.

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[i] **Conclusions and Recommendations**

The Space Task Group in its study of future directions in space, with recognition of the many achievements culminating in the successful flight of Apollo 11, views these achievements as only a beginning to the long-term exploration and use of space by man. We see a major role for this Nation in proceeding from the initial opening of this frontier to its exploitation for the benefit of mankind, and ultimately to the opening of new regions of space to access by man.

[ii] We have found increasing interest in the exploitation of our demonstrated space expertise and technology for the direct benefit of mankind in such areas as earth resources, communications, navigation, national security, science and technology, and international participation. We have concluded that the space program for the future must include increased emphasis upon space applications.

We have also found strong and wide-spread personal identification with the manned flight program, and with the outstanding men who have participated as astronauts in this program. We have concluded that a forward-looking space program for the future for this Nation should include continuation of manned space flight activity. Space will continue to provide new challenges to satisfy the innate desire of man to explore the limits of his reach.

We have surveyed the important national resource of skilled program managers, scientists, engineers, and workmen who have contributed so much to the success the space program has enjoyed. This resource together with industrial capabilities, government, and private facilities and growing expertise in space operations are the foundation upon which we can build.

We have found that this broad foundation has provided us with a wide variety of new and challenging opportunities from which to select our future directions. We have concluded that the Nation should seize these new opportunities, particularly to advance science and engineering, international relations, and enhance the prospects for peace.

We have found questions about national priorities, about the expense of manned flight operations, about new goals in space which could be interpreted as a "crash program." Principal concern in this area relates to decisions about a manned mission to Mars. We conclude that NASA has the demonstrated organizational competence and technology base, by virtue of the Apollo success and other achievements, to carry out a successful program to land man on Mars within 15 years. There are a number of precursor activities necessary before such a mission can be attempted. These activities can proceed without developments specific to a Manned Mars Mission—but for optimum benefit should be carried out with the Mars mission in mind. We conclude that a manned Mars mission should be accepted as a long-range goal for the space program. Acceptance of this goal would not give the manned Mars mission overriding priority relative to other program objectives, since options for decision on its specific date are inherent in a balanced program. Continuity of other unmanned exploration and applications efforts during periods of unusual budget constraints should be supported in all future plans.

We believe the Nation's future space program possesses potential for the following significant returns:

- new operational space applications to improve the quality of life on Earth
- non-provocative enhancement of our national security
- scientific and technological returns from space investments of the past decade and expansion of our understanding of the universe

- low-cost, flexible, long-lived, highly reliable, operational space systems with a high degree of commonality and reusability
- international involvement and participation on a broad basis

[iii] Therefore, *we recommend—*

That this Nation accept the basic goal of a balanced manned and unmanned space program conducted for the benefit of all mankind.

To achieve this goal, the United States should emphasize the following *program objectives:*

- increase utilization of space capabilities for services to man, through an expanded space applications program
- enhance the defense posture of the United States and thereby support the broader objective of peace and security for the world through a program which exploits space techniques for accomplishment of military missions
- increase man's knowledge of the universe by conduct of a continuing strong program of lunar and planetary exploration, astronomy, physics, the earth and life sciences
- develop new systems and technology for space operations with emphasis upon the critical factors of: (1) commonality, (2) reusability, and (3) economy, through a program directed initially toward development of a new space transportation capability and space station modules which utilize this new capability
- promote a sense of world community through a program which provides opportunity for broad international participation and cooperation

As a focus for the development of new capability, *we recommend* the United States accept the long-range option or goal of manned planetary exploration with a manned Mars mission before the end of this century as the first target.

[iv] In proceeding towards this goal, three phases of activities can be identified:

- *initially,* activity should concentrate upon the dual theme of exploitation of existing capability and development of new capability, maintaining program balance within available resources.
- *second,* an operational phase in which new capability and new systems would be utilized in earth-moon space with groups of men living and working in this environment for extended periods of time. Continued exploitation of science and applications would be emphasized, making greater use of man or man-attendance as a result of anticipated lowered costs for these operations.
- *finally,* manned exploration missions out of earth-moon space, building upon the experience of the earlier two phases.

Schedule and budgetary implications associated with these three phases are subject to Presidential choice and decision at this time with detailed program elements to be determined in a normal annual budget and program review process. Should it be decided to develop concurrently the space transportation system and the modular space station, a rise of annual expenditures to approximately $6 billion in 1976 is required. A lower level of approximately $4-5 billion could be met if the space station and the transportation system were developed in series rather than in parallel.

For the Department of Defense, the space activities should be subject to continuing review relative to the Nation's needs for national security. Such review and decision processes are well established. However, the planned expansion of the DoD space technology effort and its documented interest in the Space Transportation System demands continued authoritative coordination through the Aeronautics and Astronautics Coordinating Board to assure that the national interests are met.

[v] The Space Task Group has had the opportunity to review the national space program at a particularly significant point in its evolution. We believe that the new directions we have identified can be both exciting and rewarding for this Nation. The environment in which the space program is viewed is a vibrant, changing one and the new opportunities that tomorrow will bring cannot be predicted with certainty. Our planning for the future should recognize this rapidly changing nature of opportunities in space.

We recommend that the National Aeronautics and Space Council be utilized as a mechanism for continuing reassessment of the character and pace of the space program.

[1]

The Post-Apollo Space Program: Directions for the Future

I. INTRODUCTION

With the successful flight of Apollo 11, man took his first step on a heavenly body beyond his own planet. As we look into the distant future it seems clear that this is a milestone—a beginning—and not an end to the exploration and use of space.

Success of the Apollo program has been the capstone to a series of significant accomplishments for the United States in space in a broad spectrum of manned and unmanned exploration missions and in the application of space techniques for the benefit of man. In the short span of twelve years man has suddenly opened an entirely new dimension for his activity.

In addition, the national space program has made significant contributions to our national security, has been a political instrument of international value, has produced new science and technology, and has given us not only a national pride of accomplishment, but has offered a challenge and example for other national endeavors.

The Nation now has the demonstrated capability to move on to new goals and new achievements in space in all of the areas pioneered during the decade of the sixties. In each area of space exploration what seemed impossible yesterday has become today's accomplishment. Our horizons and our competence have expanded to the point that we can consider unmanned missions to any region in our solar system; manned bases in earth orbit, lunar orbit or on the surface of the Moon; manned missions to Mars; space transportation systems that carry their payloads into orbit and then return and land as a conventional jet aircraft; reusable nuclear-powered rockets for space operations; remotely controlled roving science vehicles on the Moon or on Mars; and application of space capability to a variety of services of benefit to man here on earth.

Our opportunities are great and we have a broad spectrum of choices available to us. It remains only to chart the course and to set the pace of progress in this new dimension for man.

The Space Task Group, established under the chairmanship and direction of the Vice President (Appendices A and B), has examined the spectrum of new opportunities available in space, values and benefits from space activities, casts and resource implications of future options, and international aspects of the space program. A great wealth of data has been made available to the Task Group, including reports from the National Aeronautics and Space Administration and the Department of Defense reflecting very extensive planning and review activities, a detailed report from the President's Science Advisory Committee, views from [2] members of Congress, the National Academy of Sciences Space Science Board, and the American Institute of Aeronautics and Astronautics. In addition, a series of individual reports from a special group of distinguished citizens who were asked for their personal recommendations on the future course of the space program were of considerable value to the Task Group. This broad range of material was considered and evaluated as part of the Task Group deliberations. This report presents in summary form the views of the Space Task Group on the Nation's future directions in space.

[3]

II. BACKGROUND

Twelve years ago, when the first artificial Earth satellite was placed into orbit, most of the world's population was surprised and stunned by an achievement so new and foreign to human experience. Today people of all nations are familiar with satellites, orbits, the concept of zero 'g', manned operations in space, and a host of other aspects characteristic of this new age—the age of space exploration.

The United States has carried out a diversified program during these early years in space, requiring innovation in many fields of science, technology, and the human and social sciences. The Nation's effort has been interdisciplinary, drawing successfully upon a synergistic combination of human knowledge, management experience, and production know-how to bring this Nation to a position of leadership in space.

Space activities have become a part of our national agenda.

We now have the benefit of twelve years of space activity and our leadership position as background for our examination of future directions in space.

National Priorities

By its very nature, the exploration and exploitation of space is a costly undertaking and must compete for funds with other national or individual enterprises. Now that the national goal of manned lunar landing has been achieved, discussion of future space goals has produced increasing pressures for reexamination of, and possible changes in, our national priorities.

Many believe that funds spent for the space program contribute less to our national economic growth and social well-being than funds allocated for other programs such as health, education, urban affairs, or revenue sharing. Others believe that funds spent for space exploration will ultimately return great economic and social benefits not now foreseen. These divergent views will persist and must be recognized in making decisions on future space activities.

The Space Task Group has not attempted to reconcile these differences. Neither have we attempted to classify the space program in a hierarchy of national priorities. The Space Task Group has identified major technical and scientific challenges in space in the belief that returns will accrue to the society that takes up those challenges.

Values and Benefits

The magnitude of predicted great economic and social benefits from space activities cannot be precisely determined. Nevertheless, there should be a recognition that significant direct benefits have been realized as a result of space investments, particularly from applications programs, as a long-term result of space science activities, DOD space activities, and advancing technology. These direct benefits are only part of the total set of benefits from the space program, many of which are very difficult to quantify and therefore are not often given adequate consideration when costs and benefits from space activities are weighed or assessed in relation to other national programs.

[4] Benefits accrue in each of the following areas:

economic—directly through applications of space systems to services for man, and indirectly through potential for increased productivity resulting from advancing technology; improvements in reliability, quality control techniques, application of solid state electronics, and computer technology resulting from demands of space systems; advances in understanding and use of exotic new materials and devices with broad applicability; refinement of systems engineering and management techniques for extremely complex developments.

national security—directly through DOD space activities, and indirectly through enhancement of the national spirit and self-esteem; reinforcement of the image of the United States as a leader in advanced technology; strengthening of our international posture through demonstration that a free and democratic society can achieve a challenging, technologically sophisticated, long-term objective; maintenance of a broad base of highly skilled aerospace workers applicable to defense needs; and advancement of technology that may have relevance to defense use.

science—directly through support for ground and space research programs, indirectly through ability to open to observation new portions of the electromagnetic spectrum; opportunity to search for life on other planets, to make measurements in situ at the planets or in other regions of space, and to utilize the unique environment of space (high vacuum, zero "g") for experimental programs in the life sciences, physical sciences and engineering.

exploration—the opening of new opportunities to investigate and acquire knowledge about man's environment—which now has expanded to include not only the Earth, but potentially the entire solar system.

social—providing educational services through enhanced communications which improve treatment of social problems.

international relations—providing opportunities for cooperation; the identification of foreign interests with U.S. space objectives and programs, and their results.

What is the value to be placed upon these benefits, and how should the space program be constituted to provide the greatest return in each of these areas for a selected level of public investment?

The answers to these questions cannot be stated in absolute terms—there is no dollar value associated with national self-esteem or with many of the other benefits listed above, and there is no fixed program of missions without which these benefits will not accrue. As with many programs, there is, however, a lower limit of activity below which the viability of the program is threatened and a reasonable upper limit which is imposed by technological capability and rate of growth of the program.

These limits are a key consideration in the options discussed later in this report.

[5] **National Resource**

In the eleven years since its creation, NASA has provided the Nation with a broad capability for a wide variety of space activity, and has successfully completed a series of challenging tasks culminating in the first manned lunar landing. These accomplishments have involved rapid increases to peak annual expenditures of almost $6 billion and a peak civil service and contractor work force of 420,000 people. Expenditures for NASA have subsequently dropped over the last three years from this peak to the present level of about $4 billion and supporting manpower has dropped to about 190,000 people.

In addition to NASA space activity, the DOD has developed and operated space systems satisfying unique military requirements. Spending for military space grew rapidly in the early sixties and has increased gradually during the past few years to approximately $2 billion per year.

The Nation's space program has fostered the growth of a valuable reservoir of highly trained, competent engineers, managers, skilled workmen and scientists within government, industry and universities. The climactic achievement of Apollo 11 is tribute to their capability.

This resource together with supporting facilities, technology and organizational entities capable of complex management tasks grew and matured during the 1960's largely in response to the stimulation of Apollo, and if it is to be maintained, needs a new focus for its future.

Manned Space Flight

There has been universal personal identification with the astronauts and a high degree of interest in manned space activities which reached a peak both nationally and internationally with Apollo. The manned flight program permits vicarious participation by the man-in-the-street in exciting, challenging, and dangerous activity. Sustained high interest, judged in the light of current experience, however, is related to availability of new tasks and new mission activity—new challenges for man in space. The presence of man in space, in addition to its effect upon public interest in space activity, can also contribute to mission success by enabling man to exercise his unique capabilities, and thereby enhance mission reliability, flexibility, ability to react to unpredicted conditions, and potential for exploration.

While accomplishments related to man in space have prompted the greatest acclaim for our Nation's space activities, there has been increasing public reaction over the large investments required to conduct the manned flight program. Scientists have been particularly vocal about these high costs and problems encountered in performing science experiments as part of Apollo, a highly engineering oriented program in its early phases.

Much of the negative reaction to manned space flight, therefore, will diminish if costs for placing and maintaining man in space are reduced and opportunities for challenging new missions with greater emphasis upon science return are provided.

[6]

Science and Applications

Although high public interest has resided with manned space flight, the Nation has also enjoyed a successful and highly productive science and applications program.

The list of more achievements in space science is great, ranging from our first exploratory orbital flights resulting in discoveries about the Earth and its environment to the most recent Mariner missions to the vicinity of Mars producing new data about our neighbor planet.

Both optical and radio astronomy have been stimulated by the opening of new regions of the electromagnetic spectrum and new fields of interest have been uncovered—notably in the high energy X-ray and gamma-ray regions. Astronomy is advancing rapidly at present, partly with the aid of observations from space, and a deeper understanding of the nature and structure of the universe is emerging. In planetary exploration, we have a unique opportunity to pursue a number of the major questions man has asked about his relation to the universe. What is the history of the formation and evolution of the solar system? Are there clues to the origin of life? Does life exist elsewhere in the solar system?

In the life sciences, questions about the effect of zero "g" upon living systems, demands of long-duration space flight upon our understanding of man and his interaction or response to his environment, both physiologically and psychologically, promise new insights into the understanding of complex living systems.

These are only a few of the disciplines that have profited from the program of research in space. Space science is not divorced from science on the ground, but is rather an extension of science which builds and depends vitally upon a strong ground-based foundation.

Building upon the basic science on the ground and in space, and upon the growing capability in the design, construction and launch of satellites, the United States pioneered in the development of space applications—notably communications, meteorology and navigation. Operational systems have been placed into service in each of these areas, and the potential for the future appears bright—not only in these areas but also in new fields such as earth resource surveying and oceanography.

International Aspects

Achievement of the Apollo goal resulted in a new feeling of "oneness" among men everywhere. It inspired a common sense of victory that can provide the basis for new initiatives for international cooperation.

The U.S. and the USSR have widely been portrayed as in a "race to the Moon" or as vying over leadership in space. In a sense, this has been on accurate reflection of one of the several strong motivations for U.S. space program decisions over the previous decade.

[7] Now with the successes of Apollo, of the Mariner 6 and 7 Mars flybys, of communications and meteorology applications, the U.S. is at the peak of its prestige and accomplishments in space. For the short term, the race with the Soviets has been won. In reaching our present position, one of the great strengths of the U.S. space program has been its open nature, and the broad front of solid achievement in science and applications that has accompanied the highly successful manned flight program.

The attitude of the American people has gradually been changing and public frustration over Soviet accomplishments in space, an important force in support of the Nation's acceptance of the lunar landing in 1961, is not now present. Today, new Soviet achievements are not likely to have the effect of those in the post. Nevertheless, the Soviets have continued development of capability for future achievements and dramatic missions of high political impact are possible. There is no sign of retrenchment or withdrawal by the Soviets from the public arena of space activity despite launch vehicle and spacecraft failures and the preemptive effect of Apollo 11.

The landing on the Moon has captured the imagination of the world. It is now abundantly clear to the man in the street, as well as to the political leaders of the world, that mankind now has at his service a new technological capability, an important characteristic of which is that its applicability transcends national boundaries. If we retain the identification of the world with our space program, we have on opportunity for significant political effects on nations and peoples and on their relationships to each other, which in the long run may be quite profound.

[9]

III. GOALS AND OBJECTIVES

Goals

An important aspect in both popular acceptance of the space program and in the spirit, dedication and performance of those who are directly involved in space activity is the conviction that such activity is worthwhile and contributes to the quality of life on Earth.

Public support for the space program can be related to understanding of the values derived from space activity and to understanding and acceptance of long-term goals and objectives which establish the framework for the program.

In the National Aeronautics and Space Act of 1958, the Congress declared "...it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind." This policy statement, which served effectively as a guide to the first decade in space, must now be translated into clearly enunciated new long-range goals and program objectives for the post-Apollo space program.

We view the challenge of setting new goals, of providing a focus for our future space activities, of expanding the limits of man's reach and thereby demonstrating America's leadership in scientific and technological undertakings while maintaining the confidence of the people in the strength and purpose of our Nation, as the key to continued space leadership by the United States.

Facing this challenge, some would urge that our efforts should be restricted to exploitation of existing capability, pointing out, quite correctly, that exciting and challenging missions remain to be accomplished which can utilize the existing base. But such a

course would risk loss of the foundation for future achievements—a foundation which depends largely on providing a new capability which challenges our technology.

One of the values of the lunar landing goal was that it carried a definite time for its accomplishment, which stressed our technology and served as basis for planning and for budget support. It was a national commitment, a demonstration of the will and determination of the American people and of our technological competence at a time when these attributes were being questioned by many.

The need for an expression of our strength and determination as a Nation has changed considerably since that time. Today the need is for guidance—for direction—to set before the people a vision of where we are going.

[10] Such a vision for the future should have a number of important qualities:

- it should have substantive values that are easily characterized and understood.
- it should have a long-term goal, a beacon, an aim for our activities to act as a guide to both short-term and longer range decisions.
- it should be sufficiently long-range to ensure that adequate opportunity exists for solid progress in a step-by-step fashion towards that long-term goal yet sufficiently within reach that each step draws measurably closer to that goal.
- it should be challenging both for man's spirit of adventure and of exploration and for man's technological capability.
- it should foster the simultaneous utilization of space capabilities for the welfare, security, and enlightenment of all people.

The Space Task Group has concluded that a balanced space program that exploits the great potential for automated and remotely-controlled spacecraft and at the same time maintains a vigorous manned flight program, can provide such a vision.

This balanced program would be based upon a framework in which the United States would:

- Accept, for the long term, the challenge of exploring the solar system, using both manned and unmanned expeditions.
- Develop on integrated and efficient space capability that will make Earth-Moon space easily and economically accessible for manned and unmanned systems.
- Maintain a steady return on space investments in applications, science, and technology.
- Use our space capability not only to extend the benefits of space to the rest of the world, but also to increase direct participation by the world community in both manned and unmanned exploration and use of space.

The balanced program for the future envisioned by the Task Group would possess several important characteristics:

flexibility. The ability to see clearly the opportunities that lie ahead in this new field is limited at best. Some opportunities will fade as we approach them while others, not even discernible at this time, will blossom to the first magnitude. This program will permit the course and time scale to be flexible, to adjust to variations in funding, to shifting national and international conditions, while preserving a guidepost for the future.

challenge. The space program has flourished under a set of goals that has demanded the highest standards of performance, and an incentive for excellence that has become characteristic of our space efforts. A balanced program of both challenging near-term objectives and long-range goals will enhance and preserve these attributes in the future.

[11] **opportunity**. The Nation has in being significant capability for space activity. Abundant opportunities exist for further exploitation of this capability. A balanced program

will permit adequate attention to applications and science while also creating new opportunities through development of new capability

In its deliberations, the Space Task Group considered a number of challenging new mission goals which were judged both technically feasible and achievable within a reasonable time, including establishment of a lunar orbit or surface base, a large 50-100 man earth-orbiting space base, and manned exploration of the planets. The Space Task Group believes that manned exploration of the planets is the most challenging and most comprehensive of the many long-range goals available to the Nation at this time, with manned exploration of Mars as the next step toward this goal. Manned planetary exploration would be a goal, not an immediate program commitment; it would constitute an understanding that within the context of a balanced space program, we will plan and move forward as a Nation towards the objective of a manned Mars landing before the end of this century. Mars is chosen because it is most earth-like, is in fairly close proximity to the Earth, and has the highest probability of supporting extraterrestrial life of all of the other planets in the solar system.

What are the implications of accepting this long-range goal or option on the character of the space program in the immediate future?

In a technical sense, the selection of manned exploration of the planets as a long-term option for the United States space program would act to focus a wide range of precursor activities and would be reflected in many decisions, large and small, where potential future applicability to long-lived manned planetary systems design will have relevance. In a broader sense such a selection would tend to reinforce and reaffirm the basic commitment to a long-term continued leadership position by the United States in space.

The Space Task Group sees acceptance of the long-term goal of manned planetary exploration as an important part of the future agenda for this Nation in space. The time for decisions on the development of equipment peculiar to manned mission to Mars will depend upon the level of support, in a budget sense, that is committed to the space program.

NASA has outlined plans that would include a manned Mars mission in 1981 with the development decision on a Mars Excursion Module in FY 1974, if the Nation were to accept this commitment. Such a program would result in maximum stimulation of our technology and creation of new capability. There are many precursor activities that will be required before a manned Mars mission is attempted, such as detailed study of biomedical aspects, both physiological and psychological, of flights lasting 500-600 days, unmanned reconnaissance of the planets, creation of highly reliable life support systems, power supplies, and propulsion capability adequate for the rigors of such a voyage and reliable enough to support man. Decision to proceed with a 1981 mission would require early attention to these precursor activities.

While launch of a manned Mars exploration mission appears achievable as early as 1981, it can also be accomplished at any one of the roughly biennial launch opportunities following this date, provided essential precursor activities have been carried out.

[12] Thus, the understanding that we are ultimately going to explore the planets with man provides a shaping function for the post-Apollo space program. However, in a balanced program containing other goals and objectives, this focus should not assume over-riding priority and cause sacrifice of other important activity in times of severe budget constraints. Flexibility in program content and options for decision on the specific date for a manned Mars mission are inherent in this understanding.

The Space Task Group, in response to the President's request for a "Coordinated program and budget proposal," has therefore chosen this balanced program as that plan best calculated to meet the Nation's needs for direction of its future space activity. In reaching this conclusion we have considered international and domestic influences, weighed and placed in perspective science and engineering development, exploration and application of space, manned and unmanned approaches to space missions, and have appraised

interagency influences. Discussion of the principal objectives which describe this balanced program follows.

Program Objectives

Elements of the balanced program recommended by the Space Task Group can be identified within the following set of program objectives which define major emphases for future space activity:

- Application of space technology to the direct benefit of mankind
- Operation of military space systems to enhance national defense
- Exploration of the solar system and beyond
- Development of new capabilities for operating in space
- International participation and cooperation

1. **Application of space technology to the direct benefit of mankind.**

Focus: To increase utilization of space capabilities for services to man. Programs directed toward the application of the Nation's space capabilities to a wide range of services, such as air and ocean traffic control, world-wide navigation systems, environmental monitoring and prediction (weather, pollution), earth resource survey (crops, water resources, geological structures, oceanography) and communications have great potential for improving the quality of life on this planet Earth. Significant direct economic and social benefits from such applications have been forecast. Major contributions to management of domestic problems and greater opportunities for international cooperation could result from an expanded space applications program.

2. **Operation of military space systems to enhance national defense**

Focus: Enhance the defense posture of the United States and thereby support the broader objective of peace and security for the world.

[13] The Department of Defense is presently using space capabilities in the support of communications, weather forecasting, navigation, surveillance and mapping, and for other functions. Such space activity has been not an end in itself, but a means for accomplishing functions in support of existing forces and missions. Military uses of space have proven effective and space systems are now contenders for specific applications and missions. Each military space mission should continue to be decided on a case-by-case basis in competition with ground, sea, and airborne systems and should reflect priority given to national defense with consideration of arms limitation agreements, and other U.S. policy reactions. Exploitation of the unique characteristics of space systems by the Department of Defense can provide increased confidence in the ability of this Nation to defend itself from any aggressor and assurance that space will be used for peaceful purposes by all nations.

3. **Exploration of the solar system and beyond.**

Focus: Increase man's knowledge of the universe.

Exploration of the solar system and observations beyond the solar system should be important continuing broad objectives of the Nation's space program. Many unanswered scientific questions remain about the planets, the interplanetary medium, the sun—both as a type of star and as a source of the earth's energy—and about a variety of celestial objects, such as pulsars, quasars, X-ray and gamma ray sources. Both ground-and space-based experiments and observational programs will contribute to the quest for answers to these questions. Space platforms provide several unique advantages—such as ability to observe across the range of wave lengths of the electromagnetic spectrum (rather than only through specific atmospheric "windows," which is the case from the ground); freedom from local environmental conditions; potential for continuous observations (no day-night cycle); ability

to approach, orbit and land on extraterrestrial bodies—and also disadvantages—high cost, inaccessibility for easy repair and servicing, and long lead times for experiment modification. For these reasons a careful balance between investments in space and ground experiments should be maintained.

The major elements of such a program should be:

• **Planetary Exploration**—Unmanned planetary exploration missions continuing throughout the decade, both for science returns and, in the case of Mars and Venus, as precursors to later manned missions. The program should include progressively more sophisticated missions to the near planets as well as multiple-planet flyby missions to the outer planets taking advantage of the favorable relative positions of the outer planets in the late 1970's. Early missions to the asteroid belt and to the vicinity of a comet should be planned.

• **Astronomy, Physics, the Earth and Life Sciences**—In each of these disciplines, extension of existing or planned unmanned programs promises continued high science return. There are additional significant opportunities for experiments in connection with manned Earth orbital programs which should be exploited. Work in astronomy, physics and the life sciences, as well as work in the earth sciences and remote sensing, will form an essential part of the foundation for future applications benefits and will contribute to the broadening horizons of man as he acquires knowledge not only of his own planet but also about the rest of the universe.

[14] • **Lunar Exploration**—Apollo-type manned missions to continue exploration of the Moon should proceed. The launch rate should permit maximum responsiveness to new discoveries while maintaining mission safety and efficient utilization of support personnel. Early upgrading of lunar exploration capability beyond the basic Apollo level including enhanced mobility capability, and lunar rovers, is important to safe and efficient realization of significant returns over the longer term. An orbiting lunar station, followed by a surface-base, building upon Earth orbital space station and space transportation system developments, could be deployed as early as the latter half of the decade. Extension of manned lunar activity beyond upgraded Apollo capability should include consideration of these options.

4. **Development of new capabilities for operating in space.**

Focus: Develop new systems for space operations with emphasis upon the critical factors of: commonality, (2) reusability, and (3) economy.

Exploration and exploitation of space is costly with our current generation of expendable launch vehicles and spacecraft systems. This is particularly true for the manned flight program. Recovery and launch costs will become an even more significant factor when multiple re-visit and resupply missions to an Earth orbiting space station are contemplated. Future developments should emphasize:

• Commonality—the use of a few major systems for a wide variety of missions.

• Reusability—the use of the same system over a long period for a number of missions.

• Economy—for example, the reduction in the number of "throw away" elements in any mission; the reduction in the number of new developments required; the development of new program principles that capitalize on such capabilities as man-tending of space facilities; and the commitment to simplification of space hardware.

An integrated set of major new elements which satisfy these criteria are:

a. **A space station module** that would be the basic element of future manned activities in Earth orbit, of continued manned exploration of the Moon, and of manned expeditions to the planets. The space station will be a permanent structure, operating

continuously to support 6-12 occupants who could be replaced at regular intervals. Initially, the space station would be in a low altitude, inclined orbit; later stations would be established in polar and synchronous orbits. The same space station module would also provide a permanent manned station in lunar orbit from which expeditions could be sent to the surface.

By joining together space station modules, a space base could be created. Occupied by 50-100 men, this base would be a laboratory in space where a broad range of physical and biological experiments would be performed.

Finally, the space station module would be the prototype of a mission module for manned expeditions to the planets.

[15] Such an array of space station modules would be designed to utilize the space transportation system described below.

b. **A space transportation system that will:**

- Provide a major improvement over the present way of doing business in terms of cost and operational capability.
- Carry passengers, supplies, rocket fuel, other spacecraft, equipment, or additional rocket stages to and from orbit on a routine aircraft-like basis.
- Be directed toward supporting a spectrum of both DoD and NASA missions.

Although the concept of such a space transportation capability is not new, advances in rocket engine technology, additional experience in design for reentry conditions, and improved guidance, navigation and automated check-out systems now permit initiation of an experimental effort for a Space Transportation System with technical, operational, and economic characteristics satisfying the needs of both NASA and DoD. An orderly, phased, step-by-step development program could then be implemented including as potential components:

- A reusable chemically fueled **shuttle** operating between the surface of the Earth and low-earth orbit in an airline-type mode.
- A chemically fueled reusable **space tug** or vehicle for moving men and equipment to different earth orbits. This same tug could also be used as a transfer vehicle between the lunar-orbit base and the lunar surface.
- A reusable **nuclear stage** for transporting men, spacecraft and supplies between Earth orbit and lunar orbit and between low Earth orbit and geosynchronous orbit and for other deep space activities. The NERVA nuclear engine development program, presently underway and included in all of the options discussed later, provides the basis for this stage and represents a major advance in propulsion capability.

c. **Advanced Technology Development**—In addition to the major vehicle developments listed above, a continuing program of investigation and exploration of new technology that can serve as the foundation for next generation systems is an essential component of the DoD, NASA, and other agency programs. A broad and aggressive program to advance our capabilities to operate in space during the next decade and to set the stage for the decade to follow is needed.

We foresee future requirements for larger and more efficient power supplies utilizing a range of energy sources, particularly nuclear systems, for continuing propulsion system improvements—both in performance and reliability, for improved understanding of the complex interface between man and machine, for advances in technology and systems design that result in lower cost development of new spacecraft, and for achievement of new levels of reliability. In the advanced technology program, we should emphasize biomedical research, space power and propulsion technology, both nuclear and non-nuclear, remotely controlled teleoperators, data management, multi-spectral sensors, communication and navigation technology, and experimental evaluation and demonstration of new concepts.

[16] 5. **International participation and cooperation.**

Focus: To promote a sense of world community; to optimize international scientific, technical, and economic participation; to apply space technology to mankind's needs; and to share the benefit and cost of space research and exploration.

To these ends, our international interests will be served best by (1) projects which afford maximum opportunities for direct foreign participation, (2) projects which yield economic and social benefits for other countries as well as ourselves, and (3) activities in which further international agreement and coordination might usefully be employed.

The past decade has demonstrated that programs like Project Apollo are virtually unrivaled in their capacity to catch the world's imagination and interest, win extensive admiration and respect for American achievements, and generate a common human experience. The decade has demonstrated also that effective ways can be found to share the practical benefits of space with people everywhere, as in space meteorology and communications. Modest but significant levels of direct participation in space flight research and exploration have also been successfully achieved through cooperative projects. Future program plans must seek to continue and substantially extend this experience.

We should also devote special effort to meliorate, between the space powers and others, the increasing gap in technological capability and the gap in awareness and understanding of new opportunities and responsibilities evolving in the space age.

If international participation and cooperation are to be expanded in an important way, there will have to be (1) a substantial raising of sights, interest and investment in space activity by the other nations able to do so in order to establish a base for major contributions by them; and (2) creation of attractive international institutional arrangements to take full advantage of new technologies and new applications for peoples in developing as well as advanced countries.

The most dramatic form of foreign participation in our program will be the inclusion of foreign astronauts. This should be approached in the context of substantive foreign contributions to the programs involved.

The form of cooperation most sought after by advanced countries will be technical assistance to enable them to develop their own capabilities. We should move toward a liberalization of our policies affecting cooperation in space activities, should stand ready to provide launch services and share technology wherever possible, and should make arrangements to involve foreign experts in the detailed definition of future United States space programs and in the conceptual and design studies required to achieve them. We should consider three further steps:

- The establishment of an international arrangement through which countries may be assured of launch services without being solely and directly dependent upon the United States.
- A division of labor between ourselves and other advanced countries or regional space organizations permitting assumptions of primary or joint responsibility for certain scientific or applications tasks in space.
- International sponsorship and support for planetary exploration such as that which was associated with the International Geophysical Year.

[17] The developing countries will be most attracted to (1) applications of space technology which serve their economic and social needs, and (2) the development of international institutional arrangements in which they can participate along with the advanced countries. Some examples are:

- Environmental studies and earth resource surveying via satellites;
- Direct broadcast via satellites of TV instructional and educational programs;
- Expanding arrangements to acquire and use meteorological data;
- Training opportunities in space applications and space-related disciplines.

To the extent that future practical space applications are achieved, there should be no significant technical obstacles to ensuring the sharing of benefits on a global basis. There will, however, be economic and political issues which require recognition and effective anticipation.

In the case of the USSR, experience over the past ten years makes clear that the central problem in developing space cooperation is political rather than technical or economic. Numerous specific technical opportunities for cooperation with the Soviet Union have been identified and are available. Indeed, many of them have been put to the Soviet Union in various forms through the years with little success. For example, we could formulate a series of graduated steps leading toward major cooperation. They would range from full and frank exchange of detailed space project results, at the lowest level, to prearranged complementary activities at the next level (e.q., mutual support of tracking requirements, coordinated satellite missions for specific tasks in space), and ultimately to fully integrated projects in which sub-systems could be provided by each side to carry out a total space mission of agreed character. The following possibilities merit serious consideration:

- In space research—earth orbital investigation of atmospheric dynamics and Earth's magnetic field; astronomical observations from earth satellites or lunar stations; satellite observation of solar phenomena, and lunar and planetary exploration.
- In practical applications—coordination of a continuing network of satellites to provide data for world-wide weather prediction and early warning of natural disasters; the development of capabilities for earth resource surveying via satellites.
- In manned flight—bio-medical research, space rescue, coordination of experiments and flight parameters for Earth orbiting space stations, lunar exploration, and exchange of astronauts.
- In tracking—to supplement each other's networks.

In view of the heavy commitment of the Soviets, planetary exploration appears to offer unusual opportunities for complementary activities.

[19] **IV. PROGRAM AND BUDGET OPTIONS**

The Space Task Group was asked to provide "definitive recommendation on the direction the U. S. space program should take in the post-Apollo period," through preparation of a "coordinated program and budget proposal." In the Section "Goals and Objectives," the Space Task Group has outlined the elements of this coordinated program.

We have also pointed out that there are upper and lower bounds to the Funding which will support a viable, productive and well disciplined program. Between these bounds there are many options both in program content and in total funding required. In this section we will explore the range of these options and their resource implications.

Clearly, there are a number of factors outside the space program and the intrinsic merit of it; goals and objectives that must be considered in determining the allocation of resources to the program. Demands of other domestic programs, international conditions, and state of economic health of our Nation are only a few of the major influences upon the specific budget for space in a given fiscal year.

Despite the highly variable nature of these influences, which produces a corresponding increasing uncertainty in projections of resource availability, it is important for planning purposes to look into the future and forecast the general nature of funding required to support decisions on content and pace of the program. Two basic questions arise. Is the Nation to exploit its existing capabilities, to expand those capabilities or reduce its participation in space activity? Is funding for space generally to remain at present levels, to increase dramatically or to decrease significantly below present levels?

We stand at a crossroads, with many sets of missions and new developments open to us and with three main avenues for funding to pursue these opportunities.

To assist in answering these questions and to provide a basis for Task Group analyses, NASA and DOD were each requested to prepare a set of alternative proposals or options that would cover a range of future resource levels and be consistent with the goals and objectives recommended by the Task Group.

NASA Options

The range of resource levels considered by the Task Group for NASA is shown in Figure 1.

[20] These include: (1) an upper bound, defined by a program conducted at a maximum pace—limited, not by funds, but by technology; (2) options I, II, and III which illustrate programs consistent with the Task Group recommendations, but conducted under varying degrees of funding restraints; and (3) a low level program constructed with an increased unmanned science and applications effort consistent with the Task Group recommendations but, because of the significantly lower budget levels, without a manned flight program after completion of Apollo and Apollo Applications.

A comparison of the timing of major mission accomplishments under the various programs is indicated in Table 1.

Although the program represented by the upper bound appears technically achievable, would provide maximum stimulation to our over-all capabilities, and is fully consistent with the Task Group recommendations, it represents on initial rate of growth of resources which cannot be realized because such budgetary requirements would substantially exceed predicted funding capabilities. This has therefore been rejected by the Space Task Group, and is presented only to demonstrate the upper bound of technological achievement.

We have therefore developed a set of options which falls within these limits to illustrate programs conducted at budget levels which appear possible during the next decade.

Option I is illustrative of a decision to increase funding dramatically and results in early accomplishment of the major manned and unmanned mission opportunities, including launch of a manned mission to Mars in the mid-1980's, establishment of an orbiting lunar station, a 50 man earth-orbit space base and a lunar surface base. Funding would rise from the present $4 billion level to $8-10 billion in 1980. Decision to proceed with

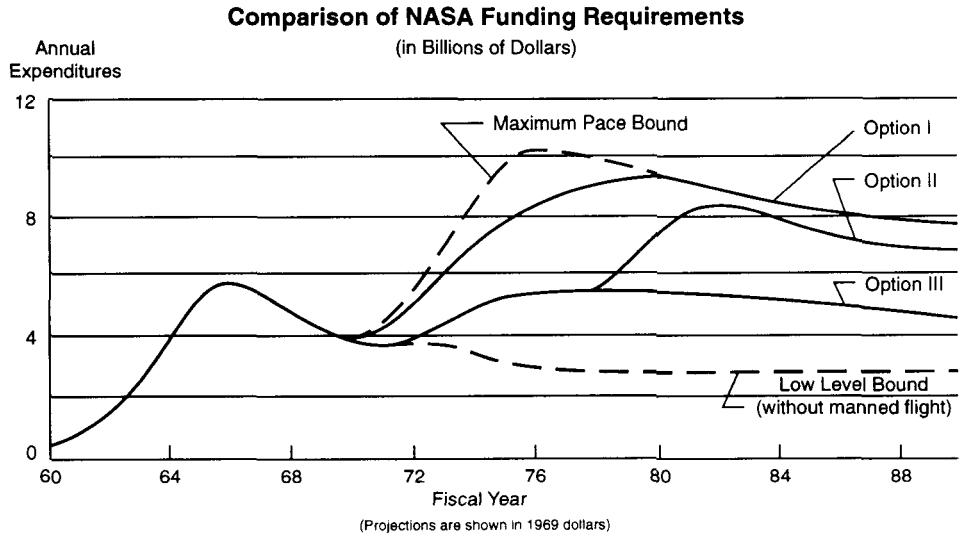

Figure 1

Comparative Program Accomplishments

Milestones	Maximum Pace	Program I	II, III	Low Level
Manned Systems				
Space Station (Earth Orbit)	1975	1976	1977	—
50-Man Space Base (Earth Orbit)	1980	1980	1984	—
100-Man Space Base (Earth Orbit)	1985	1985	1989	—
Lunar Orbiting Station	1976	1978	1981	—
Lunar Surface Base	1978	1980	1983	—
Initial Mars Expedition	1981	1983	II–1986 III–Open	—
Space Transportation System				
Earth-to-Orbit	1975	1976	1977	—
Nuclear Orbit Transfer Stage	1978	1978	1981	—
Space Tug	1976	1978	1981	—
Scientific				
Large Orbiting Observatory	1979	1979	1980	—
High Energy Astron. Capability	1973	1973	1981	1973
Out-of-Ecliptic Survey	1975	1975	1978	1975
Mars—High Resolution Mapping	1977	1977	1981	1977
Venus—Atmospheric Probes	1976	1976	Mid-80s	1976
Multiple Outer Planet "Tours"	1977–79	1977–79	1977–79	1977–79
Asteroid Belt Survey	1975	1975	1981	1975
Applications				
Earliest Oper. Earth Resource System	1975	1975	1976	1975
Demonstration of Direct Broadcast	1978	1978	Mid-80s	1978
Demonstration of Navigation Traffic Control	1974	1974	1976	1974

Table 1

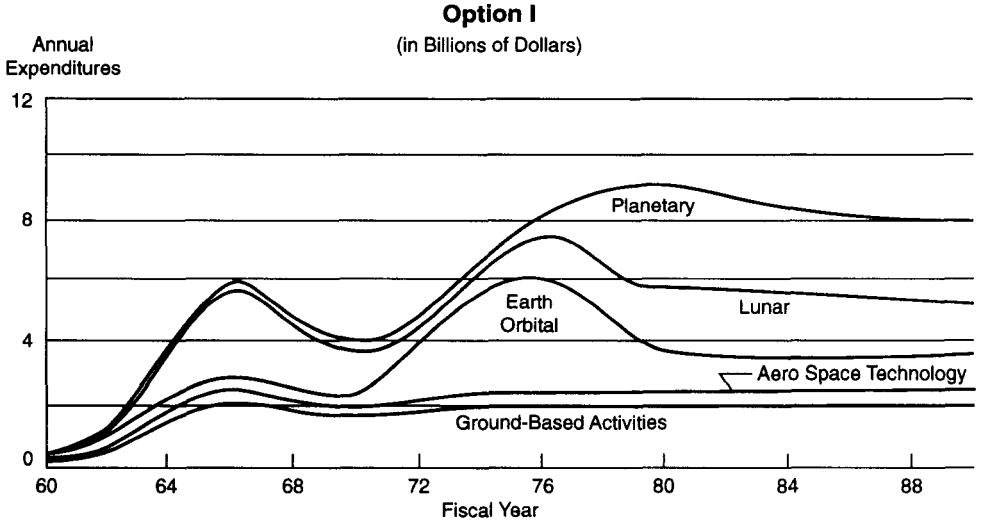

Figure 2

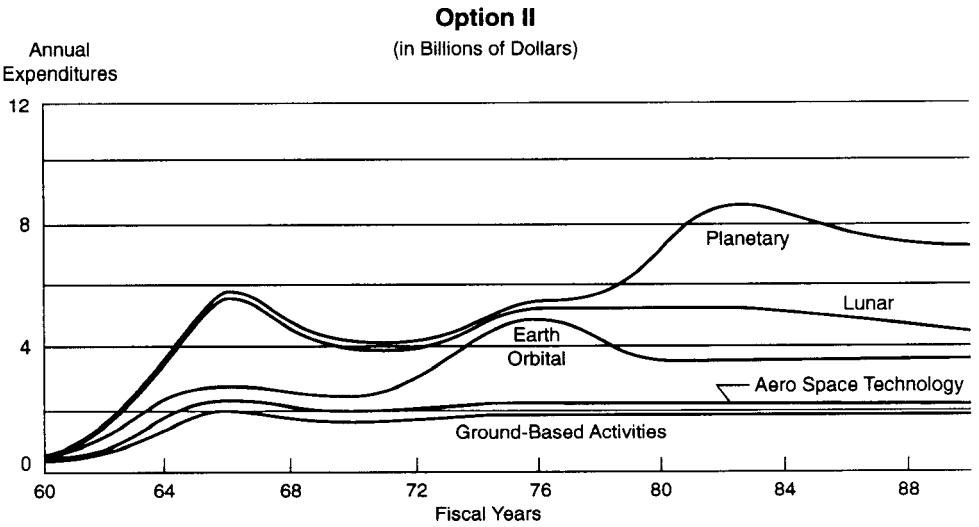

Figure 3

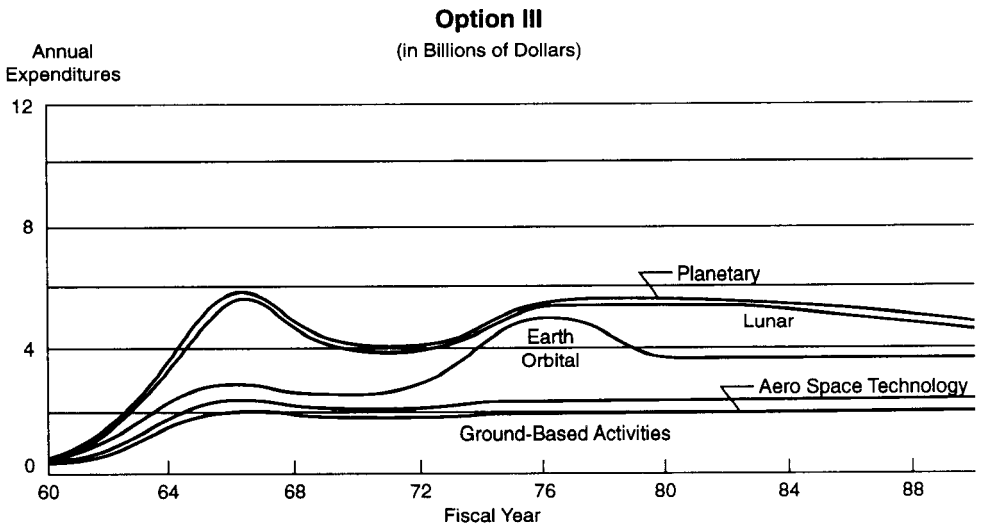

Figure 4

development of the space station, earth-to-orbit shuttle and the space tug would be required in FY 1971. Firm decisions [21] on other major systems or missions would not be needed until later years; for example, a decision to develop the Mars excursion module for an initial manned Mars expedition would not be required before FY 1974.

Options II and III illustrate a decision to maintain funding initially at recent levels and then gradually increasing. These options are identical with the exception that Option II includes a later decision to launch a manned planetary mission in 1986 and in Option III this decision is deferred. Both options demonstrate the effect of simultaneous development of the Space Transportation System and earth orbital space station module, each of

Funding for NASA Program
Options I, II, and III

Total Expenditures (Millions of Dollars)

	FY 70	71	72	73	74	75	76	77	78	79	80
Option I	3900	4250	4850	5850	6800	7700	8250	8750	9100	9350	9400
Option II	3900	3950	4050	4250	5000	5450	5500	5500	5650	6600	7650
Option III	3900	3950	4050	4250	5000	5450	5500	5500	5500	5500	5500

(Projections In 1969 Dollars)

Table 2

which is expected to require peak expenditure rates of the order of $1 billion per year, and both options include a substantial increase in unmanned science and applications from present levels but less than that in Option I. Maintaining the unmanned program at the Option I levels would require several hundred million dollars in additional funding. Decision to develop both space station and earth-to-orbit shuttle would be in about FY 1972, resulting in initial availability of these systems in 1977. Similarly, other major milestones would occur later, with decision on the Mars Excursion Module estimated for FY 1978. Funding for both options would remain approximately level at $4 billion for the next two fiscal years and then would rise to a peak of $5.7 billion in 1976—this increase reflecting simultaneous peak resource requirements of space station and space shuttle developments. If these developments were conducted in series, lower funding levels ($4-5 billion) could be achieved. Option II would have a later peak of nearly $8 billion in the early 1980's resulting from the manned Mars landing program.

Details of funding requirements for each of the program options are shown in Figure 2 through 4 and Table 2.

[23] The lower bound chosen by the Space Task Group illustrates a program conducted at significantly reduced funding levels. It is our judgment that, in order to achieve these significantly reduced NASA budgets, it would be necessary to reduce manned space flight operations below a viable minimum level. Therefore, this program has been constructed assuming a hiatus in manned flight following completion of Apollo applications and follow-on Apollo lunar missions. It thus sacrifices, for the period of such reduced budgets, program objectives relating to development of new capability, and the contribution of continuing manned space flight to several of the other program objectives recommended by the Task Group. It does, however, include a vigorous and expanded unmanned program of solar system exploration, astronomy, space applications for the benefit of man and potential for international cooperation. Funding for such a program would reduce gradually to a sustaining level of $2-3 billion depending upon the depth of change assumed for the supporting NASA facilities and manpower base.

The Space Task Group is convinced that a decision to phase out manned space flight operations, although painful, is the only way to achieve significant reductions in NASA budgets over the long term. At any level of mission activity, a continuing program of manned space flight, following use of launch vehicles and spacecraft purchased as part of Apollo, would require continued production of hardware, continued operation of extensive test, launch support and mission control facilities, and the maintenance of highly skilled teams of engineers, technicians, managers, and support personnel. Stretch-out of mission or production schedules, which can initially reduce total annual costs, would result in higher

unit costs. More importantly, very low-level operations are highly wasteful of the skilled manpower required to carry out these operations and would risk deterioration of safety and reliability throughout the manned program. At some low level of activity, the viability at the program is in question. It is our belief that the interests of this Nation would not be served by a manned space flight program conducted at such levels.

DOD Options

A similar set of DOD Options, A through C, was constructed to illustrate three basically different levels of military space activity.

Three options are presented, not only to provide funding and program options, but also to characterize the band of choices within which a rational program of military space activities will evolve. Options A and C are considered to be the upper and lower boundaries of probable military space activity, with Option B being an example of an intermediate level.

Option A presumes a future in which the threat to national security could evolve in an increasingly hostile manner, thereby leading to increased priorities for national defense and military space activities. This option also provides for contingency efforts designed to accommodate a high degree of uncertainty in future international conditions. Cost effectiveness, technology availability, growth rate of resource application, and national policy constraints were considered in establishing this upper option for a full military space capability.

[24] Option B includes those efforts necessary to counter the known and generally accepted projections of the threat. In addition, it provides limited developmental activities toward those capabilities needed if the threat increases. Option B is a prototype program which recognizes the need to minimize cost increases over the next few years, but reflects the expectation that military space activity will increase to provide the necessary support to our military forces and posture. This option is consistent with national and DOD policies and with Force Structure planning.

Option C is directly responsive to current national economic constraints, and assumes that a lessening of world tensions will result in reduced emphasis on national defense. It, therefore, includes a lower level of system deployment than the other two options. It still includes, however, the technology and support effort necessary for contingency planning, together with those programs now considered to be reasonable and predictable requirements. Option C is the lower boundary of military space activity that will meet existing national defense needs, although implied in this option is a higher degree of risk than that inherent in Options A and B.

Annual resource requirements for the DOD options are shown in Figure 5.

Program Flexibility

In the option; submitted by NASA and DOD, resource requirements have been projected which represent a large number of decisions to be made in sequence over a number of years. Thus, the resource projections represent the upper envelope or sum of funds required to support these decisions. Many of these decisions are relatively independent—that is, an earth orbit space station module can be developed independently, without commitment to placing such a station in orbit around the moon, or sending such a module on a mission to Mars. In both of these examples, however, development of the space station module would [25] be the normal first step in achieving the lunar orbit station or Mars mission capability. An example of the set of major program elements and hence decision points inherent in the options described, based upon NASA Option II, is included as Figure 6. A diversity of specific programs with varying emphasis can be constructed by delaying or shifting initiation of funding for these major elements relative to other new developments.

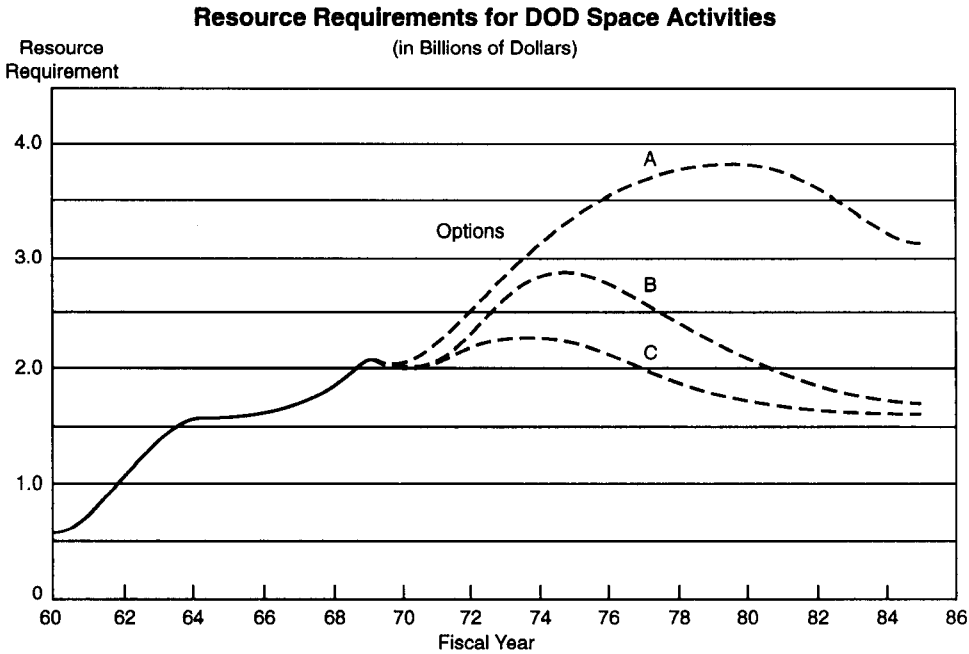

Figure 5

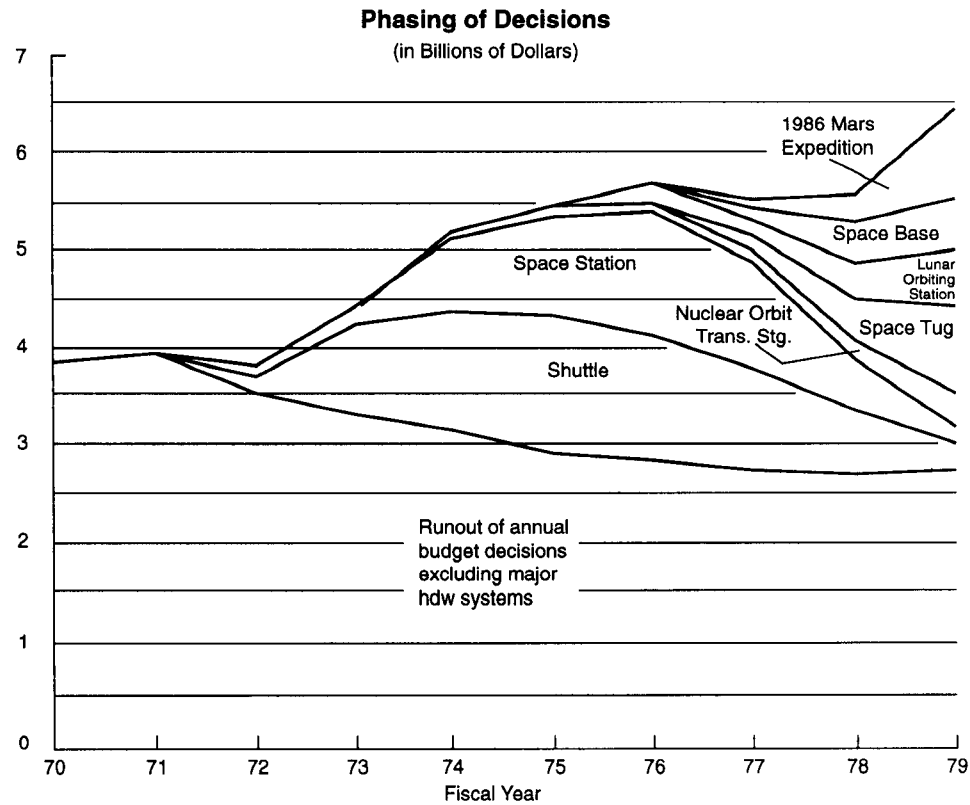

Figure 6

There is, therefore, a great amount of flexibility inherent in each of these options and adjustments to funding constraints may be made on a yearly basis as part of the normal budget process. Of course, once initiated, a specific major system development profits from continuity in funding—stretchout or major fluctuations in funding for a particular project generally increase the total costs associated with it.

The levels of activity for the NASA and the DOD programs are essentially independent, that is, selection of Options I or II for NASA could be consistent with an Option A, B, or C level of activity for DOD, since the DOD space activity will continue to be responsive to national defense needs and will be determined on a case-by-case basis under the budget and program established annually for the Defense Department. It is important, however, that continued coordination of the NASA and DOD programs and the effect of each agency's activity on a common industrial and facility base receive authoritative attention....

[29] Appendix B

SPACE TASK GROUP MEMBERSHIP

CHAIRMAN

THE HONORABLE SPIRO T. AGNEW
Vice President of the United States

MEMBERS

THE HONORABLE ROBERT C. SEAMANS
Secretary of the Air Force

THE HONORABLE THOMAS O. PAINE
Administrator
National Aeronautics and Space Administration

THE HONORABLE LEE A. DUBRIDGE
Science Adviser to the President

OBSERVERS

THE HONORABLE U. ALEXIS JOHNSON
Under Secretary of State
For Political Affairs

THE HONORABLE GLENN T. SEABORG
Chairman
Atomic Energy Commission

THE HONORABLE ROBERT P. MAYO
Director
Bureau of the Budget

Document III-26

Document title: Robert P. Mayo, Director, Bureau of the Budget, Memorandum for the President, "Space Task Group Report," September 25, 1969.

Source: NASA Historical Reference Collection, History Office, NASA Headquarters, Washington, D.C.

Bureau of the Budget Director Robert Mayo had first been critical of NASA's desire for a continued high budget when dealing with Thomas Paine's attempt to get an early presidential commitment to a space station and an increase in the NASA budget when the new Nixon administration had asked its agency heads to find ways of reducing their budgets. Mayo had been an observer in the Space Task Group, and he had made occasional comments about the difference between what the task group seemed to want to recommend and the budget outlook in coming years. This memorandum, written ten days after the president received the Space Task Group report, foreshadowed a bitter battle between NASA and the White House over the fiscal year 1971 budget level. NASA in October 1969 requested a fiscal year 1971 budget of $4.497 billion; by the time the President finally approved the budget the following January, it had been cut almost 25 percent, to $3.33 billion. Although Mayo left his position after the fiscal year 1971 budget was submitted, the newly renamed Office of Management and Budget continued to attempt to reduce NASA budget levels in subsequent years.

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[1]

Memorandum for the President

Subject: Space Task Group Report

This memorandum presents a summary of my views on the Space Task Group Report and my recommendations as to the next steps in the decision process. I was an observer on the Space Task Group and, as such, participated in its discussions on the future of the space program, reserving the right to present to you my independent judgment as your Budget Director.

The report sets forth an excellent catalog of technical possibilities for the future. However, standing by itself, it has several shortcomings. In my view, these shortcomings impair its completeness as a vehicle for your *final* decision.

1. The report does not clearly differentiate between the values of the manned space flight program versus a much less costly unmanned program with its greater emphasis on scientific achievement and potential economic returns.

2. The Space Task Group could not, nor did it try to, assess the relative standing of the space program in our full range of national priorities. In order to do this, you might wish to have the report reviewed by the Cabinet—and perhaps the Security Council as well.

3. The Group could not address the future economic context within which the recommended space expenditure would have to be considered.

4. The report is written in such a way that your endorsement of any of the recommended program options implies endorsement of major new long-term development projects, which are included in *all three* of the program options. Therefore, in a practical sense, the report gives you little flexibility except as to timing (and therefore annual costs). The impact of this is only slightly softened by the assertion that the rate of progress toward the goals would be subject to annual budget decision. This reservation has very practical limits. All the defined options involve significant budget increases over current levels.

5. The Bureau of the Budget has not had the opportunity to review in detail the estimates set forth on page 22 of the report, but they vary sufficiently from other estimates

which have been used recently so that we believe they are significantly underestimated. Furthermore, these figures are presented in terms of 1969 dollars and are therefore further underestimated by reason of the inflation that has already taken place.

[2] Of course, there is no reflection on price increases that are almost certain to come in the years ahead.

The other decision factors that most concern me are related specifically to the 1971 budget, now under preparation, and to the budgets that you will be preparing during the remainder of your first term.

The 1971 problem is severe because of:

1. The inflation we are still trying to bring under control.
2. The need to assume continuation of the Vietnam conflict for budget preparation purposes.
3. The commitments we have already made in such areas as domestic welfare, manpower training, social security benefits, revenue sharing, airports/airways, mass transit, and supersonic transport development among others. Every one of these commitments requires outlay increases in 1971.
4. Uncontrollable items such as interest on the national debt.
5. Revenue losses associated with the tax bill—even with proposed Treasury amendments.

In light of these circumstances, I gave NASA an official budget planning target of $3.5 billion for 1971 ($350 million below 1970). This target was based on the assumption that after the manned lunar landing, some reduction in NASA's current budget levels could be made to ease our overall budget problem, without stopping the manned space program. All three options set forth in the report require 1971 budgets of at least $100 million plus price increases above the current NASA funding levels and further increases in following years. These increases will have to come from programs of other agencies.

Because the Space Task Group report has now been published, your endorsement now of any specific option will commit us to annual budget increases of at least the magnitudes specified in the report. Therefore, you could lose effective fiscal control of the program.

I am convinced that a forward-looking manned space program can be developed for you that does not involve commitments to significant near-term budget increases.

Such a program would involve a slower rate of manned Apollo flights than NASA now considers desirable. It would also involve consecutive rather than simultaneous development of a space transportation system and space station, which are necessary steps toward a manned Mars mission. I intend to explore such a program in some detail with Dr. Paine during the FY 1971 budget decision process. Such a program could be accelerated in the future if conditions permit.

[3] I believe this course would be preferable to announcing ambitious long-range plans now and then having to cut back in the future due to economic constraints.

In this circumstance, I recommend:

1. That you withhold announcement of your space program decision until after you have reviewed the report recommendations specifically in the context of the total 1971 budget problem.
2. That you ask the Cabinet and perhaps the NSC to consider the Space Task Group report during October or November and advise you of their views on its recommendations, so that you will have those views in mind during your budget decisions.
3. That you consider meeting with Tom Paine and me after I have had an

opportunity to discuss with him the lower cost program option I have described above. Your meeting could be planned for December, and could serve as the final step in your decision process on the NASA 1971 budget. At that time, it is essential that you specify program content as well as budget guidance in order to help maintain effective fiscal control of the program.

4. That your space program decisions be announced in the State of the Union address, the budget message, or a special message to the Congress in the spring of 1970.

Robert P. Mayo
Director

Document III-27

Document title: Peter M. Flanigan, Memorandum for the President, December 6, 1969.

Source: NASA Historical Reference Collection, History Office, NASA Headquarters, Washington, D.C.

It was not only a desire to reduce the federal budget that led the White House in late 1969 to seek a lower level of spending on space. There was also a belief among many of Richard Nixon's political and policy advisers that there was little political benefit to the president from major post-Apollo space initiatives. This memorandum from Assistant to the President Peter Flanigan, who had been asked by the president and his top policy adviser John Erlichman to be the White House link to NASA, is an example of the political input being provided to the president.

Memorandum for the President

The October 6 issue of *Newsweek* took a poll of 1,321 Americans with household incomes ranging from $5,000 to $15,000 a year. This represents 61% of the white population of the United States and is obviously the heart of your constituency. Of this group, 56% think the government should be spending less money on space exploration, and only 10% think the government should be spending more money.

Peter M. Flanigan

Document III-28

Document title: Caspar W. Weinberger, Deputy Director, Office of Management and Budget, via George P. Shultz, Memorandum for the President, "Future of NASA," August 12, 1971.

Source: NASA Historical Reference Collection, History Office, NASA Headquarters, Washington, D.C.

In the summer of 1971, NASA and the White House were once again locked in a bitter battle over the agency's future programs and budgets. At issue was whether NASA would receive approval to continue the Apollo program through the Apollo 16 and 17 missions and to begin developing a reusable space transportation system, the space shuttle. Observing the interactions between NASA and the Office of Management and Budget (OMB) staff and other White House elements, OMB Deputy Director Caspar Weinberger decided that budget cutting was going too far. His August 12, 1971, memorandum is the

"smoking gun" with respect to the White House decision to approve the shuttle. President Nixon read the memorandum, wrote "OK" next to Weinberger's proposal to find money from elsewhere in the budget to fund NASA at a level adequate to support shuttle development, and wrote "I agree with Cap" next to OMB Director George Shultz's name on the first page of the memorandum. White House staffer Jon Huntsman reported the president's decision to Budget Director Schultz in a cover memorandum.

This exchange between Weinberger and the president was not reported to lower OMB staff, who continued through the rest of 1971 to oppose the shuttle and to propose further reductions in the NASA budget.

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[1]

Memorandum for the President

From: Caspar W. Weinberger
Via: George P. Shultz
Subject: Future of NASA

Present tentative plans call for major reductions or change in NASA, by eliminating the last two Apollo flights (16 and 17), and eliminating or sharply reducing the balance of the Manned Space Program (Skylab and Space Shuttle) and many remaining NASA programs.

I believe this would be a mistake.

1) The real reason for sharp reductions in the NASA budget is that NASA is entirely in the 28% of the budget that is controllable. In short we cut it because it is cuttable, not because it is doing a bad job or an unnecessary one.

2) We are being driven, by the uncontrollable items, to spend more and more on programs that offer no real hope for the future: Model Cities, OEO, Welfare, interest on National Debt, unemployment compensation, Medicare, etc. Of course, some of these have to be continued, in one form or another, but essentially they are program, not of our choice, designed to repair mistakes of the past, not of our making.

3) We do need to reduce the budget, in my opinion, but we should not make all our reduction decisions on the basis of what is reducible, rather than on the merits of individual programs.

[2]4) There is real merit to the future of NASA, and to its proposed programs. The Space Shuttle and NERVA particularly offer the opportunity, among other things, to secure substantial scientific fall-out for the civilian economy at the same time that large numbers of valuable (and hard-to-employ-elsewhere) scientists and technicians are kept at work on projects that increase our knowledge of space, our ability to develop for lower cost space exploration, travel, and to secure, through NERVA, twice the existing propulsion efficiency of our rockets.

It is very difficult to re-assemble the NASA teams should it be decided later, after major stoppages, to re-start some of the long-range programs.

5) Recent Apollo flights have been very successful from all points of view. Most important is the fact that they give the American people a much needed lift in spirit, (and the people of the world an equally needed look at American superiority). Announcement now, or very shortly, that we were cancelling Apollo 16 and 17 (an announcement we would have to make very soon if any real savings are to be realized) would have a very bad effect, coming so soon after Apollo 15's triumph. It would be confirming in some respects, a belief that I fear is gaining credence at home and abroad: That our best years are behind us, that we are turning inward, reducing our defense commitments, and voluntarily starting to give up our super-power status, and our desire to maintain world superiority.

America should be able to afford something besides increased welfare, programs to repair our cities, or Appalachian relief and the like.

6) I do not propose that we necessarily fund all NASA seeks—only that we couple any announcement to that effect with announcements that we *are* going to fund space shuttles, NERVA, or other major, future NASA activities....