Document III-5

Document title: McKinsey and Company, Inc., "An Evaluation of NASA's Contracting Policies, Organization, and Performance," October 1960 (a report prepared under contract for NASA).

Source: NASA Historical Reference Collection, NASA History Office, NASA Headquarters, Washington, D.C.

NASA Administrator T. Keith Glennan began 1960 with an eye to the future, concerned with establishing policies to guide NASA's external relationships with other government agencies and private industry. Knowing NASA would be contracting out the majority of its work through various field centers with differing characteristics, and recognizing that his actions would set a precedent for the agency in years to come, Glennan felt it important to acquire outside advice on these issues. Consequently, he hired the management consulting firm of McKinsey and Company to undertake an extensive study of how NASA might best establish these external relationships. Reporting back eight months later, McKinsey laid out a number of recommendations. The first chapter of the firm's report summarized them.

Document III-4

[1] February 29, 1960

Memorandum for Distribution

Subject: Appraisal of NASA's Contracting Policy and Industrial Relations

A contract has been entered into with *McKinsey and Company*, Management Consultants, for a comprehensive study of (1) how NASA should utilize industry and private institutions, (2) method of utilizing in-house research capabilities, and (3) the extent and manner of sharing responsibility and authority between government and industry. Now that our field organizations are shaping up, it seems particularly important to study very carefully how NASA can best conduct its business with industry in carrying out the program planned for the next 10 years and in a context decentralizing the major elements of industry relationships to the development centers.

The study will follow three basic approaches: (1) an examination of our experience to date in handling several major contracting actions; (2) an appraisal of experience of other government agencies; and (3) an analysis of approaches and techniques used or advocated by our own centers. I urge all elements of NASA to be fully and completely cooperative in working with the McKinsey staff.

In the past NASA has found that it obtains the greatest results from such studies if the outside consultant group has a close liaison with responsible program areas most involved. In this instance, our plan is to assign one NASA staff member to work virtually full time with the McKinsey staff. This person in turn will be assisted by and will head up a task group of people from various parts of NASA Headquarters. The task group will be composed of the following people:

Leader—William P. Kelly, Jr.—Office of Business Administration
Member—Newell Sanders—Office of Space Flight Programs
Member—Col. D. H. Heaton—Office of Launch Vehicle Programs
Member—Emerson V. Conlon—Office of Advanced Research Programs
Member—Walter D. Sohier—Office of General Counsel
Member—John R. Scull—Office of Program Planning and Evaluation

In addition, it is requested that each NASA research and development center, including the Jet Propulsion Laboratory, designate a top level technical person with management responsibility as a point of contact for the study group with that center. The name of the individual so designated should be supplied in writing to the leader of the NASA task group, Mr. William P. Kelly, Jr., Chief, Procurement Assistance Branch, Procurement and Supply Division, Office of Business Administration, NASA Headquarters, as soon as possible.
[2] Attached for your information is a brief summary of the study purposes and objectives. I believe this is a timely study of one of our major problem areas and can result in a major contribution toward improved program management if it is properly and enthusiastically pursued.

T. Keith Glennan
Administrator

Attachment as stated

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[Attachment p. 1]

February 29, 1960

Preliminary Outline of Plan for Appraising NASA's Contracting Policies and Industry Relationships

NASA is now a principal source of government contracts and may be expected in the future to contract for the requirements of an even larger space program. It is dependent upon its ability to contract effectively for the industrial and scientific resources of the nation to carry out the national space program. NASA has now (and probably only within the next year) the opportunity to appraise objectively and to revise imaginatively its contracting policies and relationships with private industry and institutions.

Scope and Objectives of the Study

This study is to be primarily concerned with an analysis of the basic concepts of (1) how NASA should utilize industry and private institutions, (2) the method of utilizing in-house research and development capabilities, and (3) the extent and manner of sharing responsibility and authority between government and industry.

The answers that this study seeks must be reconcilable with (1) the ten-year planned program, (2) the present order of magnitude of in-house development resources (at least through Fiscal Year 1961), and (3) NASA's basic policy of decentralizing major elements of the contracting job (and related industry relationships) to the development centers. These factors establish a basic frame of reference against which the feasibility of recommendations must be tested.

A study of NASA contracting at this time should be designed to provide factual and reasoned answers to the following (and related) questions:

1. What role should the space development centers—Goddard, Huntsville, and JPL—play in contracting? How does this role relate to the need for in-house development and engineering capabilities? Which of several approaches should be followed by the development centers in contracting, e.g., contracting with a single company for a major system as [2] contrasted with contracting sub-systems and components with several companies? To what extent should the approach be varied in terms of the type of project involved? What are the implications of various approaches to contracting in terms of laboratory requirements for personnel and facilities, and in government-industry relationships?
2. Under what circumstances, and for what reasons, should NASA employ each of the following in systems management?
   a. NASA space development center.
   b. Industrial contractor as solely a systems manager.
   c. Industrial contractor as systems manager and prime contractor.
   d. University or other type of nonprofit contractors as systems manager with an industrial prime contractor as in the *Vega* case.
3. What approaches and techniques should NASA use in supervising contractor operations and in evaluating contractor performance—from both a technical and administrative point of view? How should these techniques be varied in terms of (a) contractor capabilities, (b) amount of advanced research and development involved, (c) priorities, and (d) similar factors? What decisions should be made by the development centers and various elements of the headquarters staff in contractor supervision? What information is required to make these decisions effectively and how should it be provided?
4. How and to what extent should NASA encourage elements of United States industry not now interested in or involved in space technology to enter the field?
5. What new approaches can be developed to provide effective incentives to industry to control costs and increase performance? On what types of contracts, and under what circumstances, can these innovations to contracting be employed?*

[3] 6. What problems does NASA's present approach to contracting cause in terms of the agency's internal processes, particularly program planning, integration, and control? What changes are indicated in terms of either contracting policies or internal processes to increase the agency's over-all effectiveness?

7. To what extent is NASA limited by the government frame-work in making desirable changes in its approaches to contracting and in its relationships with contractors? What steps should be taken to modify or remove these limitations?

An Approach to the Study

To answer these questions a three-pronged approach to fact finding and analyses will be undertaken:

1. Appraise NASA's contracting experience by examining a sample of representative contracts NASA has executed.** The analysis of the actions taken on each contract should provide effective insights as to actual experience. To this end the Study Team will, with the aid of NASA's staff, select contracts that provide

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* Recognition must be given to the difficulties involved in providing effective incentives in rapidly evolving areas of research and development.

** This technique has been tested in an extensive study of "Weapons Acquisition" now under way at the Harvard Graduate School of Business Administration in collaboration with the Rand Corporation.

contrasting approaches to contracting, e.g., the McDonnell Corporation contract for the Mercury Capsule and the role of the Langley Research Center; *Vega* and the role of JPL; and the North American contracts for the "big engine" and the role of headquarters. The Study Team would not expect to derive answers to the questions listed above from the analysis of any sample of contracts alone.

2. Appraise the experience of other government departments and agencies in contracting for research and development projects. Evidence would be sought as to the advantages and disadvantages of the differing approaches employed, e.g., AEC in reactor development; the Army in a program such as *Jupiter*, the Air Force on *Atlas*; and the Navy on *Polaris*. In addition, the contracting practices of one [4] large laboratory outside the NASA and AEC orbit will be reviewed, e.g., Lincoln Laboratory of the Massachusetts Institute of Technology.
3. Analyze the contracting approaches and techniques now being employed by the Development Operations Division, the Space Project Group, and JPL. This approach will include assembling specific illustrations of the advantages and disadvantages of the various approaches to contracting represented by these three groups. In addition, review and appraise the procedures followed by one or more of NASA's Research Centers to make certain that the contracting requirements and procedures at these Centers will not be incompatible with the policies to be recommended.

Specific Steps Involved in the Study

More specifically, the Study Team proposes to proceed as follows:

Approximate Timing	*Steps*
Feb. 29–Mar. 18	1. ***Finalize Detailed Study Plan:*** To make more precise the types of information and analyses required, the ideas of key personnel in NASA headquarters, Langley, Goddard, and at JPL as to materials and experience relevant to the questions listed above will be assembled. This step will also involve establishing criteria for the selection of contracts to be studied. At the completion of this step, the Study Team will: a. Formulate, in terms of outlines and questionnaires, the specific detailed inquires to be made at NASA headquarters, NASA development and research centers, successful industrial contractors, unsuccessful contractors, and other government departments and agencies (Army, Navy, Air Force, and AEC).

[5] *Approximate Timing*	*Steps*
Feb. 29–Mar. 18 (continued)	b. Make a detailed presentation to the top staff of NASA—both headquarters and field—picturing the study objectives and plans. This will be done to ensure understanding of the kinds of issues and problems the study seeks to resolve, and the kinds of evidence, experience, and opinion that will be required to resolve these problems. It will be important that this step result in a consensus among key personnel as to the desirability of the study objectives and the feasibility of the approach. The Study Team will evaluate with the Administrator, at this point, the adequacy of the study plans, and the reactions of NASA's staff to these plans.

Approximate Timing | *Steps*

Mar. 21–May 13

2. ***Assemble Contracting Experience:*** This step will involve three simultaneous efforts:
   a. In assembling and analyzing NASA's contracting experience, the Study Team will be seeking information on such questions as:
      (1) Where did the idea for the project come from? What program decisions gave rise to it? Was its feasibility adequately considered?
      (2) Were in-house capabilities available for all or part of the project? What factors such as cost, were considered in making the decision to place the contract with an industrial firm or private institution?
      (3) What criteria or guidelines were used to select organizations to submit proposals?
      (4) What factors were considered in evaluating proposals and what was the relative significance of each factor in negotiating and awarding the contract?

[6] *Approximate Timing* | *Steps*

Mar. 21–May 13

      (5) What major technical, timing, and cost modifications were required in the contract and for what reason? Who made these decisions and on what basis? What has been the impact of these changes in NASA (e.g., reprogramming of available funds) and on the contractor?
      (6) How are the contractor's operations supervised and his performance evaluated?
   b. In assembling and analyzing the experience of other government departments and agencies, the Study Team will want to determine why certain approaches have been selected for the contracting of specific research and development programs rather than others, e.g., the Special Projects Office in the case of Polaris; the separation of technical and management supervision in the case of certain Air Force contracts; the management services contract for systems management on the Atlas; and the Army approach of in-house systems management.
   c. In assembling and analyzing the contracting approaches employed within the NASA centers at Huntsville, Langley, and JPL, the Study Team will want to determine what circumstances created or accounted for the different approaches to contracting and the specific advantages and disadvantages of the varying approaches, in terms of concrete illustrations.

Approximate Timing	*Steps*
May 16–June 24	3. ***Develop Preliminary Findings, Conclusions, and Recommendations:*** This step will involve (a) preparing a series of discussion papers on each of the study's major objectives, and (b) subjecting these discussion papers to the review and criticism of key headquarters and field personnel. [7] This step has a dual purpose—(a) to refine the conclusions and recommendations, and (b) provide a basis for achieving a consensus among key NASA personnel as to the approaches NASA should take to contracting and government-industry relationships in the future.
June 27–June 29	4. ***Prepare Final Report:*** The Study Team's objective will be to present a final report that sets forth recommendations and implementing action steps that have, for all practical purposes, been agreed to by key headquarters and field personnel. The previous study steps are designed with this objective in mind.

Document III-5

[1]

An Evaluation of NASA's Contracting Policies, Organization, and Performance National Aeronautics and Space Administration

1—How Better to Perform NASA's Contracting Job— A Summary of Recommendations

Importance of Contracting to NASA's Total Job

No single element of NASA's management is as essential to the accomplishment of NASA's job as the ability to contract effectively for the research, development, production, and services required. The volume of work to be done and the fast range of scientific and engineering skills involved require that NASA utilize effectively through contracts those enterprises—universities or business firms—that possess the skills required.

Approximately 85 percent of NASA's annual appropriations, hence, are spent on contracts. This fact is illustrated by the following table:

	Estimated Obligations FY 1960 (millions)		*Budget Estimate FY 1961 (millions)*	
	Dollars	*Percent*	*Dollars*	*Percent*
Contracts	468	85.2	770	84.2
Personnel	81	14.8	145*	15.8
Total	549	100.0	915	100.0

* Increase due largely to added personnel costs resulting from transfer of Development Operations Division (Marshall Space Flight Center) from Army to NASA effective beginning with Fiscal Year 1961.

[2] **Factors That Condition NASA's Job**

The manner in which the contracting job is carried out is conditioned by four factors—(1) the unique characteristics of NASA's job, (2) the legislative framework within which NASA operates, (3) the political sensitivity of contracting, and (4) the manner in which NASA came into being.

(a) Characteristics of NASA's job

NASA's ultimate objective is the acquisition, evaluation and dissemination of scientific information. Space vehicles and associated hardware provide the tools to achieve this objective. This means that most of NASA's contract dollars go for never-before-produced experimental equipment and systems, requiring diverse engineering and scientific skills.

The bulk of NASA's contracting, hence, is carried out on a cost-plus-fixed-fee basis. This method of contracting demands a closer day-to-day working relationship between NASA's technical and procurement specialists than other methods of procurement in such areas as the preparation of work statements, analyses of costs, in selecting suppliers, and in progress reporting and evaluation.

Contracting for such efforts is complicated further by the fact that many projects utilize industrial resources on what is essentially a "one time basis." The enterprise that contracts to carry out a NASA project may have to assemble scientists, engineers, technicians, and facilities especially adapted to an unprecedented undertaking. Upon completion of the project the "team" and facilities may no longer be required. There is little need for the repetitive production of a succession of items (e.g., as in aircraft or even military missile systems) but for the production of a single or very limited number of launch vehicles and space craft. Procurement of a small number of unique items places major stress on the reliability of each item.

The high reliability requirements, plus the small number of similar units that are used, are central characteristics that distinguish and complicate NASA's procurement job. These characteristics mean that the normal cost and performance incentives are often not available to NASA and contractors. Therefore, NASA must substitute for the self-discipline of such incentives continual and effective technical supervision of contractor's efforts.

[3] Over and above its own immediate needs for the services of industrial enterprises, NASA has a longer-run obligation in a free enterprise society to provide industry opportunities to take advantage of the commercial aspects of research and development.*

The goods and services that NASA contracts for and the distribution of contracts among suppliers inevitably condition the capacity of American industry and of individual enterprise to participate in those areas where (a) commercial applications are foreseeable, e.g., communications, and (b) where space research and development has an indirect impact on industrial technology and commercial products, e.g., electronics.

These factors also determine the extent of economic concentration or dispersion that will characterize the supplying industry in the decades ahead. At present, relatively few industrial concerns possess the engineering and scientific skills requisite to the successful completion of a total space vehicle subsystem such as the launch or space vehicle. However, unless industrial contractors are encouraged to round out their capabilities, NASA will find it necessary to expand its in-house capabilities—facilities and personnel wise.

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* Some of the problems involved were set forth in an address by Ralph J. Cordiner, Chairman of the Board, General Electric Company, entitled "Competitive Private Enterprise in Space" at the University of California, Los Angeles, May 14, 1960.

(b) The Legal Framework of Contracting

The National Aeronautics and Space Act of 1958 provided NASA broad authority "to enter into . . . and perform such contracts . . . or other transactions as may be necessary to the conduct of its work and on such terms as it may deem appropriate." The Act also made applicable to NASA the provisions of the Armed Services Procurement Act of 1947.

These legislative grants of procurement authority were designed (1) to grant NASA the same flexibility to procurement as is available to the military and (2) to avoid the imposition of an additional set of procurement regulations with which industry would have to cope. This latter point is of particular [4] significance since a substantial proportion of NASA's requirements are similar to those of the military departments and are produced by the same companies.

The contracting authority granted by the Congress has made it possible for NASA to depend on the military departments during its first two years of existence for substantial assistance in contracting. Without this assistance it would have been impossible for NASA to have achieved as much in the time that has elapsed. However, this dependence has influenced the speed and effectiveness with which NASA has developed its own organization and contracting processes. It has also limited the extent to which NASA has been able to initiate new approaches and techniques for contracting for research and development.

(c) Political Sensitivity of Contracting

No aspect of NASA's job is more politically sensitive than the contracting process. In substantial part this political sensitivity arises out of the large value of the contracts being let and their significance to individual contractors and to the communities in which their plants are located. A second cause of this sensitivity is the fact that the contracting activities of large government agencies have become instruments for achieving indirect objectives. These include (1) assisting small business, (2) channeling public funds into depressed and labor surplus areas, (3) maintaining a broad national industrial based for mobilization, and (4) supporting academic and institutional programs.

NASA's public and Congressional relations will depend, in considerable part, upon the manner in which the contracting process is carried out.

(d) NASA's Organizational Inheritance

NASA's organization was built on the foundations of the NACA laboratories. The traditional job of these laboratories had been in-house supporting research for the military departments and the aircraft industry. Their staffs had little experience in contracting for complex development projects.

The Jet Propulsion Laboratory, prior to its transfer to NASA, had been primarily concerned with the in-house development of Army missile systems. Although this laboratory had spent approximately half of its annual budget via contractors and vendors, the items contracted for consisted primarily of raw materials, parts, components, and similar items. Laboratory [5] personnel possessed little or no experience in contracting with industry for major subsystems of the nature involved in NASA's program.

The individuals making up these groups had been primarily concerned with in-house development and had had little experience in utilizing non-governmental contractors for development of subsystems as distinguished from components. The staff of the Development Operations Division of the Army Ballistic Missile Agency had had a markedly different experience but this staff was similarly oriented toward in-house development.

A further factor conditioning NASA's contracting processes was the inheritance by the Agency of a number of projects that had already been initiated by other agencies. These include the Vapor Magnetometer Project, initiated by the Naval Research Laboratory; the Saturn Launch vehicle by the Advanced Research Projects Agency of the Department of

Defense and the Development Operations Division of the Army Ballistic Missile Agency; the Centaur launch vehicle initiated by the Air Force; Tiros I, a project conceived and initiated by the Army Signal Corps; and Echo, a project developed by the Langley Research Center of NACA.

Each of these projects involved differing approaches to (a) the division of effort between government and private resources, (b) project management, (c) technical supervision of contractor efforts, (d) contract administration, and (e) progress reporting, including financial and procurement control processes.

Method of Analysis

In studying NASA's approach to its contracting job, we took the pragmatic approach of analyzing step-by-step twelve significant space flight and launch vehicle projects. The projects studied are identified in Table 1—"Framework for Analyzing NASA's Contracting Policies."* For each project, we studied the

[6] 1. Division of effort between NASA and private contractors in terms of the major elements (e.g., detailed design) that comprise each project.

2. Varying approaches employed in contracting, i.e., relying for the project on a single contractor, procuring subsystems from various contractors, and procuring components to be assembled with NASA.

3. Varying approaches employed in project management.

4. Techniques employed in technical supervision and administration of contracts.

In addition to these analyses of NASA's experience, we:

1. Studied the working relationships between technical and Procurement staffs in the headquarters and in the field centers.

2. Acquainted ourselves with the comparable contracting experience of our agencies, i.e., the Departments of the Air Force, Navy, Army, and the Atomic Energy Commission.

Summary of Recommendations

The results of these analyses are set forth in the following chapters of this report. Here we summarize those recommendations on which action has already been initiated or on which we urge that action be taken.

1. NASA has made significant progress in reorienting staffs that had been oriented toward in-house research and development and in increasing the utilization of industrial enterprises and other non-governmental contractors. To stimulate further contracting out, we recommend that NASA approve and generally promulgate the following criteria to govern what work shall be done in-house, and what shall be contracted out:

(a) NASA should retain in-house the conceptual and preliminary design elements of a major project, or its equivalent, in each major program.**

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* In addition to the project listed, we examined various aspects of contracts of the F-1 engine; Minitrack; research Grants and Contracts at Johns Hopkins and Stanford Universities and at the Massachusetts Institute of Technology; Atlas—Able Space Probe; Snap 8; GE Plug Nozzle engine; nuclear rocket plump; and Deep Space Net.

** Major programs include—(1) Applications, (2) Manned Space Flight, (3) Lunar and Planetary, (4) Scientific Satellite, (5) Sounding Rocket, and (6) Launch Vehicle. . . .

[7]

Table 1
Framework for Analyzing NASA's Contracting Policies

Space Flight Projects	*Estimated Obligations FY1960* (Millions of Dollars)*		*Distribution of Responsibilities*			
	In-House	*Out-of-House*	*Program Mgmt*	*Project Mgmt*	*Contract Admin.*	*Principal Contractors*
Mercury	3.8	87.2	OSFP	STG	Navy/Air Force	McDonnell, Convair, Western Electric**
Ranger	5.5	10.9	OSFP	JPL	Air Force	Convair, Lockheed
OAO	0.5	0.3	OSFP	GSFC	Air Force	Convair, Lockheed
S-16	0.05	2.1	OSFP	GSFC	Air Force	Douglas, Ball Brothers
P-14	0.7	0.2	OSFP	GSFC	Air Force	Douglas, MIT, Varlan
Echo	0.05	3.2	OSFP	GSFC	Air Force	Douglas, Bell Telephone, General Mills, MMM
Launch Vehicle Projects						
Saturn	43.0	135.3	OLVP	MSFC	Air Force	Douglas, Convair, Rocketdyne
Centaur	0.2	36.5	OLVP	MSFC	Air Force	Convair, Rocketdyne
Agena-B	0.1	7.3	OLVP	JPL	Air Force	Convair, Lockheed
Delta	0.7	11.8	OLVP	OLVP	Air Force	Douglas
Scout	0.05	2.5	OLVP	Langley RC	Navy	Chance Vought
Vega	0.1	3.5	OLVP	OLVP/JPL	Air Force	Convair
Total $	56.1	300.8				
Total %	18.8	81.2				

* The in-house estimates include obligations from the Salaries and Expenses Appropriation; out-of-house obligations from the Research and Development Appropriation. The estimates were obtained from the various project managers and reflect the general magnitudes only.

** The Western Electric contract for the Mercury tracking system is supervised by the Langley Research Center.

[8] (b) NASA's in-house efforts in the conceptual and preliminary design elements of space flight and launch vehicle projects should be supplemented extensively through the use of study contracts.

(c) NASA should retain in-house the detailed design, fabrication, assembly, test and check out elements of a single advanced launch vehicle* and spacecraft unique to each major program.

(d) Each center should contract out the detailed design, fabrication, assembly, test, and check out elements of all launch vehicles and spacecraft except the relatively few required to meet the criteria set forth in item (c) above.

(e) NASA's centers should contract all production manufacturing efforts including the standard or relatively standard parts and components used for in-house launch vehicles and spacecraft of an advanced developmental nature.

(f) NASA should contract out total space vehicles including the physical integration of subsystems, i.e., the launch vehicle and spacecraft.

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* Or stage in the case of a project such as the Saturn Launch Vehicle, i.e., the S-I Stage.

(g) NASA should contract with the external scientific community for a preponderant proportion (70 to 85 percent) of all space flight experiments.

Adoption of these criteria will ensure the retention in-house of the capability required to enable NASA effectively to contract for the bulk of the research and development services needed. Adoption of the criteria will curb the tendency to do all that can be done in-house and contract out what remains.

2. To utilize its in-house facilities to the fullest, we recommend that NASA:

[9] (a) Place responsibility for a limited number of development projects in the research centers where they have the capabilities required, and these capabilities are needed by NASA for the particular project.

(b) Establish project management teams in the Research Centers where this means a center's capabilities can best be utilized to provide needed development assistance.

3. The complex character of space vehicle subsystems makes inevitable the distribution of responsibility among several NASA centers and among industrial contractors. To resolve more effectively the technical (in matching up one space vehicle subsystem with another) and jurisdictional problems (headquarters staffs vs. center staffs) that arise, we recommend that NASA:

(a) Assign as full responsibility as practicable for the execution of each project to a specific center.

(b) Clarify the relative responsibilities of the headquarters staff and the space flight centers by concentrating the efforts of the headquarters staffs on reviewing and approving:

(1) Development plans for each space flight project, including conceptual and preliminary designs and allocation of responsibilities in- and out-of-house.

(2) Schedules in terms of major procurement actions and technical milestones.

(3) Budget justifications and financial operating plans.

In addition, the headquarters technical staffs would evaluate projects and approve changes in the project plans which significantly alter objectives, schedules, and/or costs.

4. Strengthen the capabilities of the space flight centers to manage projects, particularly those in which major systems or total space flight vehicles are developed by contractors. To this end, we recommend that NASA:

[10] (a) Improve the competence of its project managers. Steps must be taken to ensure that project managers develop the full complement of technical and managerial skills essential for this task. The "custom-tailored" training program for project management personnel that has been initiated is a promising step toward this end.

(b) Improve the project organizational arrangements that now exist. Each project management team responsible for a major space flight project should be headed by a full-time project manager reporting directly to the director or deputy director of the responsible center.* Each project management team should include sufficient technical and administrative (e.g., financial procurement) personnel to make the project manager effective in mobilizing the resources of the whole center, of other centers, and of the contractors.

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* Because of the inability to attract senior project managers at the salary level NASA is able to offer, achievement of this objective will require, in a number of cases, a considerable period of time.

5. NASA is faced with a major and complex task of developing, under cost-plus-fixed-fee contracts, working relationships with contractors which neither stifle the contractor's capabilities, nor relieve them of their obligations to use public funds wisely and economically. To this end, we recommend that NASA:

(a) Develop a guide for preparing and evaluating statements of work to be done and service to be rendered under research and development contracts.

(b) Institute a continuing program to assemble and study cost data as a basis for improving funding estimates.

(c) Provide a single point of ultimate technical authority for each contractor on a given project—the project manager.

(d) Establish guidelines as to the approaches and techniques to be used in technical supervision of contractors.

[11] (e) Establish guidelines as to staff action on the analysis and control of costs in terms of pre-award analyses of price, costs, and profits, and post-award costs control techniques.

(f) Continue to make its own source selections, handle its own contract negotiations, and provide its own technical supervision.

(g) Supplement use of the military services for "field service functions" by periodic evaluation of services rendered, direct handling when required in special situations, and approval of subcontracts within clearly prescribed criteria.

6. To overcome apparent deficiencies in the functioning of the headquarters Procurement and Supply Division, we recommend:

(a) Approval of the organizational plan prepared by the Director of the Procurement and Supply Division with one major exception; that is, focus all activities related to facilities planning and utilization in a separate division in the Office of Business Administration rather than in a branch of Procurement and Supply Division.

(b) Development of a system of field center procurement reviews with will involve key personnel from each of the branches of the headquarters Procurement and Supply Division. This step plus the one recommended in item (a) above will make it possible to abolish what is presently termed the Field Installations Branch in the Procurement and Supply Division.

(c) Establishment of a position of Assistant Director in the Procurement and Supply Division.* The person appointed to fill this position should be given primary responsibility for the day-to-day internal management of the Division.

(d) Additional staff be made available, particularly in the Policies and Procedures Branch, for the Procurement Committee, and in the Procurement Assistance Branch.

[12] 7. NASA's technical staff have reflected lack of understanding of the processes that must be carried out if their needs for research and development services are to be translated into contracts with qualified suppliers and NASA's resources are to be conserved. To overcome this lack, we recommend that steps be taken to aid the technical staffs—in headquarters and in the centers—in expanding their understanding of the:

(a) Succession of actions that the procurement staff must take to negotiate and administer a contract.

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* Action has been taken to establish such a position.

(b) Importance of keeping procurement staffs advised of needs that will affect procurement actions.
(c) Importance of recognizing what constitutes contractual commitments and refraining from making them without advice from NASA procurement staffs.
(d) Importance of cost analysis and negotiation and tolerance of the time that is required.

There is no simple nor established method of creating understanding and acceptance of these points by technical personnel. The primary obligation falls on NASA's management. It is to establish in day-to-day practice—at headquarters and in the field centers—the concept of team action on procurement matters.

To implement this concept requires the availability of procurement personnel who are strongly program oriented, while at the same time possessing outstanding experience in, and a clear understanding of, the contracting processes associated with complex research and development projects—including their financial and program implications.

8. Most of the development contracts that are still being awarded and supervised by NASA headquarters can be associated either with a specific project or with the technical skills available in one of the field centers. Wherever this is the case these contracts should be technically supervised and administrated from a given field center rather than from headquarters. In a very limited number of cases it may be appropriate for NASA headquarters to award and supervise contracts related to the development and feasibility of future programs. This should knowingly be the exception to the general rule.

[13] 9. All contracts now supervised from headquarters that can be associated either with a specific project or with the specific skills of one of the field centers should be technically supervised and administered from the field centers; for example, those advanced technology studies for the development of solid rocket motors which are technically supervised from headquarters and administrated by the Goddard procurement office.

Document III-6

Document title: James E. Webb, Address at Graduation Exercises, Advanced Management Program, Graduate School of Business Administration, Harvard University, December 6, 1966.

Document source: Administrators' Files, NASA Historical Reference Collection, NASA History Office, NASA Headquarters, Washington, D.C.

Experienced in public management, NASA Administrator James E. Webb considered the development of new approaches to management an important goal of the Apollo project. His emphasis called for the assimilation of concepts and processes from government, industry, and academia into a usable form. In this 1966 graduation address at the Harvard Business School, Webb took the opportunity to explain his view of the interaction of various communities on space flight management, as well of NASA's broader contribution to public administration.

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[1] During the time spent here, you have been studying the present state of the management art as it has developed in recent years. You have brought yourselves up to date, and I am certain that you hope that what you have learned will last you for at least a few years to come.

On the other hand, you came here because you are not complacent. You recognize that the world is changing and the requirements you have to meet on the job and off the

job are changing. I am sure you want to continue to keep abreast of the times.
[2] That being the case, let me take this opportunity to talk about some of the changes I see going on that challenge any new complacency you might be tempted to develop.

Let us start with some new kinds of management problems that all of us are going to be dealing with in the days and years immediately ahead. Secondly, let us move on to talk about some new approaches, new techniques and new solutions that are being tested and that have proved productive in dealing with these new kinds of problems. Some of these are too new to be written into the literature or even into the case studies generally available.

As I see it, there are new ways of thinking about management problems, new ways of doing things or getting them done in an organization, new styles of management.

I. The Changing Dimensions of the Challenge

During the years since World War II, we have all been mindful of the magnitude of the changes going on around us. The numbers needed to describe the growth in our [3] gross national product or our national income, or the magnitude of our private investment or public debt are all enormous numbers. We have heard a great deal, too, about the pace of change and about its acceleration. Much of our attention, therefore, has been given to size and speed, and to how these affect the requirements for good effective management.

I want to talk about some other dimensions of the challenge we face. As I see it, the problems that we are going to be dealing with in the days ahead of us are not just bigger than the problems our parents or grandparents were faced with. They are different in a number of important ways.

First, they are going to be more complex, in many bewildering ways.

How complex our environment is was brought forcibly to my mind in a recent article in *Business Week* on the wood product industry. Some years ago, companies in the industry who owned timberland became aware of the fact that they really had to farm their land if they wanted [4] to stay in business. They had to grow new crops of trees to replace those they cut down. Then the timber companies began to diversify, as they realized that the closer they got to the end product, the more control they had over their markets and their customers. And so timber companies began to go into all kinds of businesses. Some went one way and some another. Some went into building products and others into paper products and one into retail stationery stores. This article in *Business Week* talked about the furniture business and it told how one furniture manufacturer was building diningroom chairs of wood, except that the legs were made of plastic, because that had proved to be much stronger than wood for that purpose. In some of these companies, production of both wood and plastic parts is now controlled by punch tape and by optical scanners that trace cutting patterns electronically. As good wood gets scarcer, some companies are using thin veneers backed with aluminum foil coated with vinyl. This article then went on to describe some of the production techniques the furniture industries have borrowed from the aerospace companies, resulting in highly automated production lines [5] that produce new kinds of raw materials, and then shape them and mold them under electronic control. One company has adapted the technology of textile and paper mills to bleach natural wood to a neutral color and then stain it to produce a more uniform finish than can be found in natural timber. One company is working with epoxy impregnation of wood that has been treated with nuclear radiation to change its molecular structure. The purpose of this is to make hard wood out of pine, according to this manufacturer.

I cite this example only to illustrate one aspect of the complexity of what might appear to be a relatively simple business. It serves to illustrate kinds of decisions that the managements of even relatively small companies are faced with today, and will be faced with increasingly in the days ahead.

An interesting reflection for me as I read this article was the viewpoint of the TVA I had gained back in 1947 when, as Director of the Budget, I had made an inspection of each major river system which was being developed with Federal funds. In addition to its demonstration farms which were experimenting with various new [6] phosphates and other fertilizers developed through TVA research, experiments were being carried out to determine how the small farmer could "tree-farm" his wood lot with highest yield. Another reflection is that recently I read a report on the research which led to the radiation hardening of treated wood which had been partly financed by the Atomic Energy Commission and sponsored by the Southern Interstate Nuclear and Space Board. A wise utilization of an accumulation of technology based on research does pay off—in the health of a regional economy or in the profitability of a business. It pays off in the field of management too.

Certainly you are mindful of the fact that very few of the companies that make up *Fortune*'s list of our 500 largest industrial corporations can be said to be in any one industry, or even in two or three industries. The logic of events and of circumstances have led them to diversify all across the industrial spectrum. And most of them are just as far flung geographically as they are industrially. The search for raw materials and markets and labor supply have caused them to set up shop in one [7] country after another all around the world. Each of them has at its command many different kinds of raw materials, natural and synthetic, and many different production technologies. Products are proliferating and markets are fragmented and all of this requires different entrepreneurial skills which require new kinds of management approaches.

What is going on in the private industrial sector of our economy is also going on throughout our society. Our universities are no longer the simple "halls of ivy" they used to be. Every major university is a large complex of different and diverse highly specialized schools, and centers, and institutes, and research laboratories.

Our cultural institutions have become similarly complex. Instead of a Metropolitan Opera House or a Carnegie Hall, New York now has a Lincoln Center and a similar cultural complex is emerging in each of our metropolitan areas, or will soon emerge there. Or think of our approach to the problem of poverty. Not so many years ago, we thought of poverty in terms of incompetence or charity, in terms of drives to support charitable institutions. Now we recognize that poverty is a much [8] more complex fact, requiring a much more fundamental approach involving many different disciplines. Management of efforts to apply new approaches can only be elaborately intricate.

Not only are the challenges facing us much more complex than they used to be, but they are also involved increasingly with new sciences and new technology. Whether you think of the wood product business or the Lincoln Center complex, those who occupy the positions where important decisions are made are more and more dealing with a rapid pace of scientific and technological progress. The furniture executive has to make decisions involving optical scanners and radiation. The management of Lincoln Center finds itself dealing with scientists who are experts in acoustics one day and on the next day with engineers who are masters of the technology involved in the giant rotating mechanism that operates the center stage of the new Opera House, and with the problems posed when that breaks down the night before the new Opera House was to be the scene of its first public performance. We in NASA face the same problem when a diesel engine refuses to start and a gantry [9] cannot be lowered to accommodate a major rocket launching.

Similarly, those who work in the field of poverty are involved in the latest findings of behavioral scientists and economists. The same is true of those who are dealing in the problems of mass transportation or air pollution or management of vast health and welfare programs to serve our major communities. We in NASA are similarly involved when we have to translate a supersonic transport design into pilot performance or into a predicted return on invested capital for an airline.

And our affluent society is becoming day by day a more impatient society. Those who hold positions of responsibility are expected to be able to cope with the most complex of new scientific findings and their potential at the very frontier of technology. It was only a few years ago that Henry Ford made his contribution by putting to productive use the proven engineering practices involved in assembly line mass production. Production of things is no longer the major challenge of our society. We are dealing with problems and with solutions that involve high [10] elements of creativity and, associated with them, high degrees of uncertainty and risk. Management must be able to assess these in its decision-making. And to solve these problems we find ourselves involved with creating and learning to use different kinds of skills and talents and training.

I am reminded of the fact that not so many years ago one of our major corporations was faced with the challenge of shifting from the assembly of electrical components to the manufacture of products involving the latest developments in solid-state physics. The electrical assembly operation required long lines of women with nimble fingers. The new production line was peopled entirely by physicists with advanced degrees. This involved a different kind of recruiting, a different kind of motivation, and a much different kind of supervision. And, of course, it meant a different kind of management at the higher levels of the company. These are some of the new dimensions that we are facing in our private sector and in the public sector of our society. They define a new challenge and they require a new kind of management.

[11] **II. New Perspectives on Available Resources**

I believe we can accept the fact that today's furniture manufacture has to think of the new world of plastics as well as new kinds of treated wood. We have at our command, in other words, a much wider range of natural and synthetic materials to take into account in our critical decisions as managers.

But more important, I suspect, are the human resources we have to work with.

Our generation of managers grew up in a world in which there were some rather nice distinctions between the world of commerce, the world of the university, and the world of government. We came to think of these as quite separate, peopled with quite different kinds of human beings, with different value systems and different sets of capabilities. To some extent, at least, we thought of these as worlds in conflict with each other. One was the world of the practical man of action, the other the world of the intellectual. One was a profit motivated world and the other a world motivated by a desire to teach and to learn.

But as we look at the kind of problems facing us and accept the challenge of dealing forthrightly with these, [12] it becomes increasingly apparent that we need to learn how to work with or draw on each of these resources and learn how to meld them together and balance them in proper proportion.

Certainly we have seen this at NASA where our successes can be traced to our learning how to relate our needs and resources to the needs and resources of these great segments of our society. We have labored hard to set up a partnership in which each contributes its capabilities to and receives its rewards from the effort to master and use the air and space environments.

The first industrial revolution put to practical use the principle of standard or interchangeable parts. I suspect that the world we are making will be characterized by mobility, but also by interchangeability of people, by people who can transfer their work and talents from the university into industry or from industry into government, a mobility in any direction. The first name that comes to my mind is Robert Seamans, who was an associate professor in the Department of Aeronautical Engineering at MIT, and [13] moved from there into industry where he had a distinguished career from which he was drafted into government and is now the Deputy Administrator of NASA. There are many other examples, and the number of people who can move easily and comfortably from one of these spheres to another is increasing day by day. In dealing with the problems that you will be working on in the years ahead, you will be drawing more and more on people with this kind of talent.

III. New Kinds of Organizations

One thing that is becoming increasingly clear to students and practitioners of management is that the classic approaches to organization are inappropriate for dealing with the kind of problems we are talking about.

The earliest attempts to increase the effectiveness of organizations followed the prevailing concepts of the division of labor. The work to be done was broken down into identifiable tasks or functions, and a specialist was put at the head of each major element. This had some obvious advantages, but it also had the disadvantage of dividing responsibility into pieces that really did not [14] correspond to the reality of everything required to get the total job done. Everyone had only partial responsibility so no one had the total responsibility.

This led to the idea of decentralization, which divided the organization into units, each of which had an identifiable task, for which the head of the unit could be held responsible. This proved to have some advantages, but it had the disadvantage of weakening the leadership contribution of those responsible for giving the entire organization its direction and its momentum.

I believe we have learned that neither of these broad-brush concepts, nor any other rules of thumb, work for all organizations. They fail particularly to meet the needs and challenges we face. What we see going on today is the tailoring of new types of organizational structures and new kinds of assignments of authority and responsibility. We are hearing more and more about free-form management, which connotes the development of specific organizational approaches designed to serve a particular unit of a large complex organization. Return to earth is so important to each astronaut and to NASA that we tailor [15] to each his re-entry support or couch to give him maximum support at the time he needs it most.

In modern management, we are seeing increasing use of organizational concepts like product management and project management in which the responsibility for the development and marketing of a product, or the completion of an important project are [sic] put in the hands of one individual who has all required elements of command over all of the resources he needs to get the job done. What characterizes these new kinds of organizational structures is that they cut across the traditional proverbs used to express concepts of authority and responsibility. They utilize, rather than accept as limits, the differences of function or discipline or the division of work into bits and pieces. At NASA, the concept of project management has been applied successfully to large and complex efforts in which one individual is responsible for integrating all of the capabilities and resources necessary to get the job done. Whenever possible, even while exercising very broad authority associated with his responsibility for performance, cost, and schedule, we leave him attached to [16] the laboratory or technical group within which his technical competence was demonstrated and where the forward thrust of current research keeps him up-to-date. This also gives him easy access to colleagues who know how to wring out the facts needed for the difficult trade-off decisions.

The kind of challenges that we in management are facing today do, therefore, call for new and experimental approaches to organization. One that I think worth commenting on in detail is the question of the chief executive function. In traditional organizational thinking, the structure of an organization peaked in the chief executive, who was positioned at the top of the organizational hierarchy. This concept goes back to some of the origins of modern organizational theory and practices, to the Catholic church, and to the Prussian military, which are the prototypes of much of modern organizational thinking. However, as organizations have become more complex and their challenges more interdisciplinary, it is becoming increasingly apparent that there is nothing sacred about the notion of a single chief executive. Accordingly, there has been an increasing tendency to experiment with the idea of the multiple executive, [17] usually in the form of the "office of the president" concept. I understand that a number of important companies, including Union Carbide, General Mills, Metropolitan Life Insurance, Boise Cascade, and others, have experimented with this pragmatic approach to the requirements of managing the kind of far-flung and diverse activities over which some form of executive authority is necessary. We saw this kind of need at the very beginning of NASA's history. We evolved, therefore, a partnership arrangement which included Dr. Hugh Dryden, Dr. Robert Seamans, and myself. We all had many common ideas, and yet each brought to our work on the critical decisions affecting the nation's space effort certain specialized experience. To do it any other way would have deprived the organization of critical inputs needed for important decisions. To do it any other way would have deprived us of the kind of mutual support and broadly-based leadership that I think we achieved.

The point I want to make is that there is need for innovation and risk-taking as well as seasoned judgment in the structuring of organizations to face the challenges [18] of today. This is true in the business world. It is equally true in managing many of the other undertakings in our increasingly complex society.

IV. New Approaches and New Techniques

There are, then, no pat or ready-made organizational devices for structuring these efforts which will substitute for analysis and judgment. Neither are there approaches or techniques that can be taken off the shelf. We are in the midst of a period of innovation and experimentation in both, and there is the same need for creativity that there is in science and technology.

I find this going on in many efforts at the kind of complex problem-solving and decision-making I am talking about. Some specific examples from NASA may be helpful.

To begin with, every aspect of the aeronautical and space effort draws on many different disciplines and many different contractors and suppliers of services. Some of our sources are within NASA itself. Others are in other agencies, and still others in universities. Altogether we have over 20,000 prime, first, and second tier contractors [19] in industry, each of whom is making its contribution to the total effort.

From the beginning of the Space Act, we realized that this effort could achieve its objectives only if each of the contributions to it fit into a carefully designed, fully integrated, totally engineered system. Each of the 200 or more major projects could achieve its objectives only if its elements similarly fit together into a desired whole. In this sense, the space effort represents what is probably the greatest experiment to date in the design, development, test, and use of large complex systems and sub-systems. In this effort, we were concerned, of course, with the performance and cost of each element. We were also concerned that all could be delivered and used on a very short time-phased schedule. Ranger had to precede Surveyor, and Orbiter had to follow. Apollo needed the knowledge to be gained from each. We knew that the perfection of the parts would not guarantee the success of the effort. The interfaces among the elements were at least as important as the elements themselves, and to manage this kind of achievement we found little in the textbooks or in the case [20] histories. We did find men in our military services and in industry who had experience in the management of large projects such as Minuteman and Polaris. From the beginning we worked at developing new approaches and new techniques appropriate for the design and management of this kind of systems effort, in the open, without the protection of military security classification. One of the techniques we had to develop involved the gathering, processing, and dissemination of large amounts of information. We had to collect information on the state of each scientific and technical field in which we or our suppliers were working, and we had to make sure this information was used where appropriate. We had to establish techniques for collecting and distributing information on the state of each of our programs, so that everyone with responsibility or need-to-know could be kept informed.

Sometimes the collection and processing of data had to meet some rather strenuous deadlines. For example, a few seconds after the launch of a manned vehicle, a decision had to be made to abort or to continue the flight. [21] Thus we became involved in developing techniques for real time information processing.

Similarly, some of our projects involved many thousands of discrete activities, all of which had to be coordinated and controlled at a central point. We had to develop display techniques so that the progress of each of these elements could be displayed to teams of people working on different aspects of the same project, in a manner that made it possible for everyone to know where everyone stood at a particular moment in time. PERT in its original form was only a starting point to the development of the control technique we use at Houston and at Cape Kennedy. Again, we had to experiment and to innovate. It is gratifying that the techniques we developed have already found application outside of the space effort.

One of the principles underlying a number of our management techniques is the principle of visibility. We decided it was important that as far as possible problems be identified in a manner visible to everyone involved and that the people responsible for solving these problems be [22] visibly identified to their colleagues. A number of management techniques we have developed serve the purpose of achieving this kind of visibility of information and responsibility.

Similarly, we wanted to achieve an approach to management in which everyone with responsibility was aware that on any decision he could consult both colleagues and superiors without delay and without an involved system to assure a common basis for almost instantaneous identification of the important elements requiring attention. We had to build individual competence and confidence that work could go on with full knowledge of the individual that his superiors were literally "looking over his shoulder" at all times. We had to do this without discouraging initiative and innovation. In this kind of an effort, there was no room for protectiveness or self-consciousness. Accordingly, we developed a number of techniques to achieve this kind of real time "over the shoulder" supervision.

[23] These are only a few of the management techniques we have developed. As a result of this period of experimentation and testing, there are now available a number of techniques of proven usefulness that may well have applicability to problems in other areas of our economy and our society, in our country and around the world.

V. New Breeds of People

What kind of people do we need to manage and to carry out this kind of effort? What qualities identify the individual with this kind of temperament and capability, and how do we go about developing such people to their full potential? Very little is known about this. It is all too new. The only thing we can be sure of is that they are different kinds of people than those that have succeeded in management in the past. One characteristic we have always depended on is that of a strong urge to compete and the urge to excel. In the kind of complex challenges we are talking about, it is rarely possible to attribute a solution or an achievement to one individual. In this kind of effort the boundaries between disciplines is all [24] but erased and the skills of individuals fuse with each other. It is all but impossible to identify who has contributed some key element to the final outcome. I suspect that it is in this area of identifying the new manager and developing him to his full potential that we have the most to learn and in which the greatest progress is yet to be made. This may well be the greatest challenge to those of you who are dedicated to the art of management.

Document III-7

Document title: James E. Webb, Administrator, Memorandum for the Vice President, May 23, 1961.

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

After delivering to President Kennedy a recommendation supporting an American-piloted lunar landing program on May 8, 1961, Vice President Lyndon B. Johnson departed on a tour to review the military and political situation in Southeast Asia. Given Johnson's interest in the space program, NASA Administrator Webb prepared this memorandum for him upon his return. This memorandum is an excellent example of the broad context in which Webb was contemplating the mobilization that would be required to accomplish the Apollo program. The memorandum refers to Edward Welsh, the executive secretary of the National Air and Space Council, Secretary of Defense Robert McNamara, Deputy Secretary of Defense Roswell Gilpatric, and Glen Seaborg, the head of the Atomic Energy Commission. Webb also mentions Albert Thomas, a Democratic congressman from the Houston area and chair of NASA's Appropriations Subcommittee; George Brown, one of the principals in the Houston construction firm of Brown and Root; Jon Erik Jonsson, chairman of the board of Texas Instruments; Cecil Green, a Dallas business leader; Senator Robert Kerr of Oklahoma, chair of the Senate Committee on Aeronautical and Space Sciences; and a Charlie Jonas, Republican House member from North Carolina.

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[1] May 23, 1961

Memorandum for the Vice President

By way of a brief report, as you return to Washington, let me set down the following:

1. The President has approved the program you submitted, with very few changes, and the message will go up on Wednesday.

2. In working out this program and all of the details involved, there has been an absolutely splendid spirit of teamwork not only with Ed Welsh but with the Defense Department, the Atomic Energy Commission, and the Bureau of the Budget.

3. Considerable interest has been expressed in this program by members of the Congress, following your consultations with them, and as I have followed up, I have

impressed on them the need you have felt for action and the importance we have placed on the operating responsibilities to be carried by McNamara, Seaborg, and myself. Without exception, all have responded well to this, and many have pledged fullest cooperation and assistance.

4. In preparing for the hearings on the original Kennedy submission before the House Appropriations Committee, and in other discussions with Congressman Thomas, Thomas made it very clear that he and George Brown were extremely interested in having Rice University make a real contribution to the effort, particularly in view of the fact that some research funds were now being spent at Rice, that the resources of Rice had increased substantially, and that some 3 00 [sic] acres of land had been set aside for Rice for an important research installation. On investigation, I find that we are going to have to establish some place where we can do the technology related to the Apollo program, and this should be on the water where the vehicle can ultimately be barged to the launching site. Therefore we have looked carefully at the situation at Rice, and at the possible locations near the Houston Ship Canal or other accessible waterways in that general area. George Brown has been extremely helpful in doing this. No commitments whatever have been made, but I believe it is going to be [of] great importance to develop the intellectual and other resources of the Southwest in connection with the new programs which the Government is undertaking. Texas offers an unusual opportunity at this time due to the fact that Dr. Lloyd Berkner, Chairman of the Space Science Board of the National Academy of Sciences, is establishing a Graduate Research Center in Dallas with the backing of Erik Jonsson, Cecil Green, and others in that area (estimated at about one hundred million dollars), and in view of the fact that Senator Kerr and those interested with him in the Arkansas, White, and Red River System have now pushed it to the point that it is opening up the whole area related to Arkansas, Oklahoma, and in many ways helping to provide a development potential for Mississippi. If it were possible to get a combination where the out-in-front theoretical research were done by Berkner and his group around Dallas in such [2] a way as to strengthen all the universities in the area, and if at the same time a strong engineering and technological center could be established near the water near Houston and perhaps in conjunction with Rice University, these two strong centers would provide a great impetus to the intellectual and industrial base of this whole region and would permit us to think of the country as having a complex in California running from San Francisco down through the new University of California installation at San Diego, another center around Chicago with the University of Chicago as a pivot, a strong Northeastern arrangement with Harvard, M.I.T., and like institutions participating, some work in the Southeast perhaps revolving around the research triangle in North Carolina (in which Charlie Jonas and the ranking minority member on Thomas's Appropriations Subcommittee would have an interest), and with the Southwestern complex rounding out the situation. I am sure you know that the decisions relating to this must await the completion of the work on our program by the Congress, but I am convinced, and believe you should consider very carefully, that will attract the kind of strong support that will permit the President and you to move the program on through the Congress with minimum political in-fighting. I think this is important in the present situation and particularly to avoid the kind of end-runs that some of our friends related to the Pentagon, directly or industrially, have pursued in the past.

5. To get clearly before the country the idea that this is a national effort, the appearance which will introduce the new program to the Senate Committee on Aeronautical and Space Sciences will be made by Gilpatric, Seaborg, and myself, all three sitting together at

the witness table, and each of us presenting a brief statement to start the discussion. I believe this is the kind of image of unity and drive in the Executive Branch that you would like to see.

6. In all of the work that has gone on while you have been doing such a great service in Southeast Asia, we have emphasized the important place you and the Space Council have occupied in pressing forward for the necessary decisions. In view of this you may wish to consider some form of statement or public expression in connection with the presentation of the program to the country and to the Congress.

7. In order to discharge our obligation to give both the general public and the scientific community a report on the Shepard flight, we are having a session sponsored by NASA, the National Institutes of Health, and the National Academy of Sciences, in the State Department Auditorium on June 6th. All the people concerned with the program, and particularly those in the scientific and technological side, will be present, as will Commander Shepard. Secratary [sic] Connaly of the Navy is giving a lunch that day for Commander Shepard and Robert Gilruth, Director of the Space Task Group. Would you like to give a lunch or join with me in giving a lunch to the scientists and others on the program? Generally we have tried to avoid getting up any large lunch but could have a small one right in the [3] State Department for those actually on the program and perhaps one or two of the other leaders here that day.

James E. Webb
Administrator

Document III-8

Document title: James E. Webb, Administrator, NASA, Memorandum to NASA Program Offices, Headquarters; Directors, NASA Centers and Installations, July 5, 1961.

Source: Presidential Papers, Agency Records, John F. Kennedy Library, Boston, Massachusetts.

One justification for spending money on space is the benefit derived from "spinoffs"—knowledge or technology developed for a specific space purpose that yields benefits in different fields altogether. In this letter, Webb made an early effort to encourage NASA personnel to facilitate this process, not only to justify space spending but on the grounds that it would help the United States in its Cold War endeavor to outstrip the Soviet economy.

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[1] July 5, 1961

Memorandum

To: Program Offices, Headquarters
Directors, NASA Centers and Installations

One of the most important aspects of the space program is the possibility of the feedback of valuable, new technological ideas and know-how for use in the American economy.

Our economy is expected to grow to something over 700 billion dollars per year by 1970. In the next ten years Dodge Reports estimates that something over 700 billion dollars will be spent for building all kinds of things—highways, bridges, houses, airplanes, trains, and so forth. It also estimates that some 360 billion dollars will be spent for maintenance and repairs in this period. This means that something over a trillion dollars will be spent in America to build or repair or maintain capital items.

Under the above circumstances, any technological gains from our program, if rapidly inserted into the stream of the above activity, can yield great benefits. We must obtain this yield at the most rapid rate to stay ahead of the USSR economy, which is constantly seeking to gain from the technological ideas and know-how which are emerging from its military and space effort. Our problem is to get the feed-back into our normal stream of activity in a better manner than they are able to do.

I will appreciate your sending me any ideas you or your staff have as to specific areas connected with our program where the feed-back can be accelerated or the method of obtaining the feed-back improved.

James E. Webb
Administrator

Document III-9

Document title: James E. Webb, Administrator, Memorandum for Dr. Dryden, Deputy Administrator, "University Relationships," August 4, 1961.

Source: Presidential Papers, Agency Records, John F. Kennedy Library, Boston, Massachusetts.

In assuming the leadership of NASA, a key goal for James E. Webb was to foster space-oriented academic institutions in each of the nation's major geographic areas, with the ultimate goal of stimulating the general academic environment of each region. This plan, which would eventually be encompassed within the Sustaining University Program, broke new ground for the relationship between the federal government and universities. In this memorandum, Webb targets Rice University in Houston, Texas, as such a facility in the Southwest. A little over a month later, he recommended to President Kennedy that Houston be chosen as the site for the Manned Spacecraft Center, which became the Johnson Space Center in 1973, and thereby a focal point for the entire Apollo program. As identified in Document III-7 above, Lloyd Berkner was the chair of the National Academy of Sciences's Space Science Board.

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[1] August 4, 1961

Memorandum for Dr. Dryden—AD

Subject: University Relationships

As I believe we agreed before you started on your vacation, the whole area of developing university relationships is of very vital importance to our future, particularly the development of some centers capable of greater efforts in the space science field. Of course we must supplement this with some work with universities who can generally raise the level of education in the basic sciences, and the great reservoir remaining in the country seems to be the Middle West and the Southwest.

There are signs of stirrings in the Upper Middle West, around Minnesota, and some in the Central Middle West, around Kansas City and the general South Illinois-Missouri-Kansas area, and then quite a bit of stirring in the Southwest.

Also, the Research Institute, based on the North Carolina University complex, is making some presentations as to the things they can do in the space program. And Lloyd Berkner has suggested some activities for the Graduate Research Center.

In line with the above, I got a call yesterday from Hugh Odishaw, who says that the Provost of Rice University will be here on Tuesday of next week, and I am to meet the two of them for lunch at the National Academy of Sciences to talk over what Rice can contribute to the program. I believe we already have an active program there and have been told that the new president, Dr. Pitzer, is quite an outstanding man around which a real effort could be built.

By copy of this memorandum, in the absence of Dr. Dryden, I would like to have such information about Rice as will be helpful in conducting the above conference and endeavoring to develop the most constructive lines of interest for the agency with Rice.

James E. Webb
Administrator

Document III-10

Document title: James E. Webb, Administrator, to Dr. Lee A. DuBridge, President, California Institute of Technology, June 29, 1961.

Source: President's Science Advisory Committee Files, John F. Kennedy Library, Boston, Massachusetts.

As a master politician, NASA Administrator James E. Webb realized the need for a broad national consensus in support of the Apollo program. Recognizing that the university science community was likely to be critical, Webb reached out to explain the program as he envisioned it. This letter is one example of his approach. William Pickering, whom Webb mentions, was the director of the Jet Propulsion Laboratory at the California Institute of Technology.

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[1] June 29, 1961

Dr. Lee A. DuBridge
President
California Institute of Technology
Pasadena, California

Dear Lee:

Last night the Senate passed the full requested authorization of $1,784,000,000 for our 1962 budget, which is the first formal endorsement of the program suggested by President Kennedy. I believe this means that we will get an approval of our program somewhat earlier than I had expected and with a broader base of acceptance throughout the country than seemed indicated even two or three weeks ago.

Even so, I know the ultimate commitment to the program will depend on the way we go at the job and the results we achieve. Therefore I have been wondering if it might not be helpful if some of the leaders of American science, such as yourself, might not like to have a rather complete briefing on exactly where we stand with respect to our planning. We did have a task force drawn from our ablest people all over the country who have put together a program that appears to be capable of accomplishment, and we are now considering alternatives to see whether we can better this plan. There are several areas where competition exists, such as between the liquid and solid approach.

Would you feel it helpful to take the time, when you are next in Washington, for a quite complete briefing as to how we expect to carry out our entire ten-year program, including the lunar landing? I am taking the position that this program must be so complete and so useful that even if we never make the lunar landing, or do it after the Russians have done so, we still will have obtained outstanding value for the time and money invested. Your own judgement [sic] as to whether the program we have fits this requirement would be helpful.

[2] Another possibility, which I have discussed with several, including Bill Pickering, is that of asking a group of outstanding scientists who have expressed concerns about the program to come in for a group briefing. In this way no one would be singled out, and we would not have present anyone except those who were explaining the program. We would not have those who are in favor of the program and who might want to argue on its behalf. The purpose of this would be to facilitate the understanding which we hope everyone concerned with the program will endeavor to achieve before they take their firm and final positions on it.

As I told you by telephone when we first discussed this program, I certainly have no desire whatever to suggest that anyone who wishes to oppose the program soften his criticism. However, I do feel it quite important, under the conditions that exist in the world today, that the program be quite thoroughly understood before strong adverse positions are taken by our national leaders in any field.

Sincerely yours,

James E. Webb
Administrator

Document III-11

Document title: Hugh L. Dryden, "The Role of the University in Meeting National Goals in Space Exploration," ***NASA and the Universities: Principal Addresses at the General Sessions of the NASA-University Conference on the Science and Technology of Space Exploration in Chicago, Illinois, November 1, 1962*** **(Washington, DC: NASA, 1962), pp. 87-91.**

NASA Deputy Administrator Dryden gave this presentation at a NASA-university conference in 1962. This meeting, which was patterned after the NASA-industry conference of 1960, was the first meeting in which NASA attempted to convey to the academic world the role envisioned for universities in the Apollo program. This represented the principal address at the general sessions of the conference and pronounced formal NASA policy on the issue. As such, it was especially important as a statement of government position on the interactions of various scientific and technical organizations in conducting space exploration.

The Role of the University in Meeting National Goals in Space Exploration

[87] The last half century has brought forth a succession of new technologies, sparked by advances in scientific knowledge but brought to maturity by the interaction of scientists and engineers in an environment of national needs for national defense or social and economic development. I need only mention the technologies of aeronautics, communications, radar, nuclear energy, and, now, space. These scientific and technological developments have affected our individual lives as citizens and as professional men and women, and our social institutions, including universities, industry, and other segments of the Nation, as well as government itself. Our international relations, our social and economic development, our military strength—all have been profoundly modified by the powerful forces of science and technology.

It is my purpose to discuss the role of the university in our present-day environment, specifically its responsibilities in space exploration, the responsibilities of NASA, and our joint responsibility for promoting the national welfare.

What is the role of the university today?

There is, I think, general agreement that the university's primary objectives are the education and guidance of students and the promotion of scholarly and scientific inquiry. The ideal university is a community of scholars engaged in research and teaching. In particular, graduate education at its best rests on research, the students learning as apprentices to teachers engaged in advancing knowledge in their professional field.

Yet to state these principles is not to provide a sufficient basis for determining the role of a university. Better than I, college officials and faculty members know that this statement of principles merely indicates where the university's ultimate identity and integrity lie; it does not indicate how this state of affairs is to be achieved in the modern world.

So many at least superficially contradictory demands must be met: the requirements of teaching our swollen enrollments as opposed to those of research; the desire of the individual scholar to wend his solitary way as opposed to the rising tide of programmatic and team work; the necessity, from an institutional point of view, for drawing a balance between scholarly withdrawal—from which perspective may be gained—and an involvement with on-going life that provides both intellectual stimulation and humane feelings.

The truth is, of course, that in the modern world the university must—for its own survival, and I think for the survival of all that we hold dear—face both inward and outward; it must somehow contain the contradictory forces that threaten to tear our world apart. Because of this, university administration and faculty members bear one of the most difficult burdens of our time. We in NASA—sharing many of the same problems—are aware of this fact; and our aim is to remain aware of it in all of our activities.

In a Commemoration Day Address at the Johns Hopkins University on February 22, 1936, Isaiah Bowman presents this picture of a university which is, I think, equally applicable today:

A university is like a state in the variety of the forces that determine its life: clash of divergent opinion, power to inspire men with exalted purpose, association of distinctive personalities, ordered procedure in a self-governing system, financial perils, and even treasury crises. A citizen in a university-state is not a recluse [88] *trending daily a well-worn path of routine. True, he may deal one day with quite petty details of courses and classes; but the next day finds him standing, as it were, on the rim of the universe, analyzing the spectrum of a beam of starlight that left its remote source two hundred million years before the tree-dwelling precursors of man passed their first anxious nights on* *the ground. The range of the university's interest extends from microscope to telescope, from a student's minute personal problem to the nature and impact of social forces that are rocking the world.*

I suggest that the exploration of space is a social force which is rocking the world. I feel no hesitation whatever in saying that the university cannot ignore this force, that it has an inherent responsibility entirely apart from any thought of governmental support to contribute to this major task. Like the small nations of the world which many never launch a satellite, but which must find ways of participation in space exploration, the smallest university must contribute some of its intellectual resources and active interest. Again quoting from Bowman:

To keep research in pure science in the University actively related to social needs and national strength is a duty which cannot be evaded. Pasteur's dream of a private research institute was interrupted again and again by waking realities. There was a national need for knowledge about the silkworm disease and for an understanding of the fermentation problem. His flaming sense of social responsibility was the source of energy and inspiration in his attack upon national problems. As men of privileged education we are not being trained and equipped for isolated and protected living, playboys in the land of dreams.

Our educational institutions bear a major responsibility for the success of our national effort to explore space. Our universities and colleges are called upon to produce a body of scientists and engineers of unexcelled competence. Some of these graduates will enter governmental service with NASA and other agencies participating in the space program: some will join private research organizations and industrial corporations; but some must remain at the universities where they continue to advance knowledge and produce new talent. This last function, as previously mentioned, should receive high priority. The government laboratory, industry, the research foundation, all are users of creative and talented men without reproducing this vital national resource. The university alone is the producer of new engineers and scientists.

The university is not only a center for the development of men with eager, trained, self-starting minds but also a center of creative activity in research. The Summer-Study Committee on NASA/University Relationships of the Space Science Board of the National Academy of Sciences points out that:

. . . the opportunities for developing new fundamental knowledge and technical applications may very well equal or exceed those which have existed in the atomic and nuclear physics fields during the past thirty years. . . . A vigorous academic program in all appropriate aspects of the space endeavor must be developed. Such a program must enjoy a visible relationship to that of the federal establishment itself: but it is of utmost importance that it preserve the essential virtues of universities—a devotion to scholarly and scientific inquiry, a primary concern for the guidance and eduction of students, full freedom of discussion and publication, and essential autonomy in the formulation of research objectives and of programs of work directed toward such objectives.

Other aspects of the independent role of the university in the environment of a national program of space exploration will be discussed subsequently. Consider now NASA's specific needs for assistance from the university community. The NASA program comprises four main areas—space sciences, manned space flight, applications of earth satellites to communications and meteorology, and advanced research and technology. What help do we expect to get from the university in each of these areas?

The term "space sciences" is a shorthand expression to describe investigations in any field of science carried out by apparatus carried into space by sounding rockets, earth satellites, and lunar, planetary, or interplanetary probes. Sometimes the term is extended in meaning to include laboratory or earth-based observations related to the flight experiments. The fields of science included are, in the main, astronomy and solar physics; geophysics, including aeronomy, ionosphere physics and energetic particles and fields; interplanetary investigations; lunar and planetary investigations; and biosciences.

The NASA program in space sciences is being built on the participation by the competent scientific community. It is freely recognized that the U.S. would have no space science program worth talking about if at least some of the [89] most competent scientists of the Nation were not deeply involved in it. The importance of the creative activity of the individual working scientist in the program is paramount. It is necessary to make use of scientific competence wherever that competence may be found. Although there is significant participation by scientists within NASA, scientists in other government agencies, in the industrial community, and the international scientific community, the major element in the participating scientific community is the university community of the U.S.

The university scientist who participates in satellite and space-probe experiments finds an environment different from that to which he has become accustomed. Traditionally, a scientist conceives an experiment, builds the apparatus himself or has it built under his supervision in the university shop or by contract, carries out his experiment, analyzes the data, and publishes his results. This relatively simple procedure is not possible in satellite and space-probe experiments, although a fair approximation to it is feasible for experiments with small sounding rockets. Satellite launching requires large rockets, special launch sites, a worldwide tracking and data-acquisition network, sharing by many experimenters in a single flight, and a large team of cooperating specialists. The scientist becomes involved in scheduling his work to meet a flight date, once that date is set. His apparatus must be engineered to meet severe environmental requirements of vibration, temperature, exposure to radiation and charged particles, and so forth. Some universities are able to provide this service; others must depend on industrial help. Thus, the role of the university scientist often reduces to concept of the experiment, development of laboratory prototypes of the equipment, analysis of the data and publication, plus participation in a large team to design the actual satellite, launch it, and receive the data. NASA policy is to support the tradition of responsibility and freedom of the experimenter to the maximum extent consistent with the nature of the operation. Selection of experiments to be flown is made by a Space Sciences Steering Committee composed of scientists and engineers in NASA Headquarters who are not contenders for payload space and who have the advice and guidance of outside consultants.

In the space sciences area, NASA supports by grants the development of scientific and technical information in areas broadly related to space science as well as specific project tasks. Examples of current specific tasks are: develop, construct, and test four magnetometer instruments suitable for use on a satellite to determine the magnitude and direction of the earth's magnetic field and analyze telemetered data from the instrument; design, construct, and test a Cerenkov counter and associated circuitry to measure the energy spectrum of high energy gamma rays; test and calibrate the equipment by synchrotron or balloon techniques; and assemble instrument packages suitable for use in satellites. Examples of broader tasks in areas related to space science are: research in solar and cosmic-ray physics; theoretical research on low-energy electronic, ionic, and atomic impact phenomena; and the magnetohydrostatics of the magnetosphere of the earth and problems in theory of orbits of space vehicles.

In the field of advanced research and technology not directly connected with the flight program of sounding rockets, satellites, and space probes, NASA is interested in and supports a wide range of research activities from basic research to technological applications, from theoretical investigations to laboratory experiments. Some are related to problems of immediate operational concern; others endeavor to extend the present limits of knowledge and broaden the research capabilities available for such extension. Our quarterly program report for July 1, 1962, shows about 450 active grants and research contracts. A few of these are related to the manned space flight and the applications program of NASA but the majority are in the fields of advanced research and technology and space sciences.

Although NASA does place demands for direct assistance on the universities, we consider that we have an obligation to conduct the space program in such a way as to help strengthen the university. We wish to work within the existing university structure rather than to set [90] up independent contract-operated activities that tend to draw the university research scientist or engineer away from the teaching of students in the course of the research he performs and directs. We seek to share in a joint responsibility to add to our national strength. It is clear that NASA cannot meet all the desires or even needs of the universities or mount a program of general support to education. We have neither the responsibility nor the resources to do this. But like the logger who has a responsibility of replacing for the future the trees which he harvests, NASA, as a user of university trained talent, has an obligation to carry a fair share of the load of replacing the resources consumed. The universities must bear their share of responsibility for the success of the space program, as previously discussed, and must allocate an appropriate fraction of their own material and human resources to the effort. But NASA stands ready to invest substantial resources in partnership with the university.

Thus, in addition to direct project support, NASA initiated in fiscal year 1962, a program of enlarged scope for utilizing more fully the abilities of our universities. The program is frankly NASA-oriented but planned in such a manner to recognize the acute needs of the university as well. In brief, to meet the space program needs, we are proceeding to strengthen university participation in four ways: (1) to utilize university resources for specific research projects under grant or contract as appropriate; (2) to encourage the establishment of interdisciplinary groups for research in broad areas to be supported by grants; (3) to support the training of people in the field of space science and technology through grants; and (4) in certain cases to provide research facilities.

The first method is the traditional support of projects; the other three are new so far as NASA is concerned. The broad grants are intended to encourage the establishment of creative multidisciplinary investigations, the development of new capabilities, and the consolidation of closely related activities. As will be discussed subsequently, multidisciplinary is here intended to include not only cooperative effort among branches of the physical sciences but also between physical and biological sciences and with some participation from the social sciences, all as appropriate to the selected broad areas in which a given university possesses high competence.

The third method comprises research training grants to increase the supply of scientists and engineers in space-related science and technology. It has been estimated that by 1970 as many as one-fourth of the Nation's trained scientific and engineering manpower will be engaged in space activities, although I cannot confirm the accuracy of this estimate. For planning purposes only, we have suggested as a goal the support of about 4,000 graduate students per year in 150 qualified universities, to yield an annual output of about 1,000 new Ph.D.'s in space-related fields. In selecting universities, we consider such factors as accreditation ratings, resources, previous and current efforts in developing research activity in the space sciences, location and extent to which the region already is provided with advanced training opportunities, and so forth.

The fourth method is the provision of grants for facilities in certain cases. Consideration is given to the urgency of the need, the nature and extent of the university's involvement in space-related research, the relative importance of the research to the national space program, the demonstrated competence, past achievements, and potential future accomplishments of the research groups, and similar factors. In general, we attempt to consider a total university situation and use an appropriate mix of the several methods for the specific circumstances, subject of course to the total resources available for the program.

In FY 1962 the commitments for the support of project research at universities were of the order of $28 million and the estimate for FY 1963 indicates an increase to about $55 million. A few interdisciplinary grants date back to FY 1961. In FY 1962 eleven such grants were made, amounting to a total of about $3 1/2 million. Training grants were made to ten institutions amounting to a total of about $2 million, and facilities grants to five institutions amounting to $6 1/2 million, all of which have existing interdisciplinary activities. This total [91] of $12 million for the last three categories will be increased to about $30 million in FY 1963. The many proposals on hand are under evaluation at the present time. We recognize that a larger effort needs to be made and hope to move toward the desirable goals in succeeding years.

In recognizing the separate responsibilities and specialized interests of the universities and NASA and their interrelationships, we cannot forget other parties at interest in the space-exploration program. The major fraction of the effort, as measured by dollar value or manpower, is conducted under contract by private industry. There are many aspects of university-industry and NASA-industry relations which lie outside the province of the present discussion. Here we note only that NASA, the universities, and the aerospace industries have a collective responsibility for the conduct of the space program.

The collective responsibility goes far beyond that for the success of the technical aspects of the program, if the greatest benefit to the nation is to be realized. We have previously discussed at some length the conduct of the program in such a manner as to strengthen the universities as an element of national strength. Similar conditions apply to the aerospace industry, but our obligations extended further to every aspect of our social, economic, and political life.

Space research and development, like the predecessor fields of rapid scientific and technical advance at the frontiers of knowledge—aeronautics, electronics, and nuclear research and development—produce corollary benefits in the form of new knowledge, new products, new methods, and new materials which can be employed in the development and manufacture of countless articles for human use. In the past the transfer process proceeded in a laissez-faire manner at a relatively slow pace. We believe that it is incumbent on all of us to try to accelerate this process. We have suggested that universities participate in promoting wider use of the information obtained by associating members of the faculties in economics, business administration, and political science in the activities of the interdisciplinary groups.

It is our feeling that the universities should go still further to assert leadership in attacking the totality of problems affecting the welfare of man within their sphere of influence, whether this be a community, a region, or the entire nation. Abraham Horwitz, in discussing "The Changing Scene in Latin American Medical Education" in the *Journal of Medical Education* for April 1962, made some observations which, in the following paraphrased form, are applicable to the current situation in the United States: There is a new spirit abroad in the U.S. today, a spirit imbued with the determination to create more wealth, to distribute it more equitably, and to promote the well-being of man. The focal point of this signal endeavor should, we believe, be the universities for the primary need is for experts to put to work the capital that will be invested in systematic programs. Equally pressing is the need for a deep and searching examination of the problems that beset us and the establishment of the procedures for their solution. A debate of this kind can best be carried on in the university, which is wedded to the free examination of all problems affecting the life of man in society, and where culture, in the sense of perfection of man, has its wellspring. . . .

In summary, all of us who participate in the conduct of the space-exploration problem should endeavor to discharge our task in the light of these broader considerations of human welfare. The university has a unique opportunity, not only to perform basic research and train new talent in new areas of science and technology and to carry a large share in the scientific aspects of the space flight programs, but also to provide leadership in the wide discussion and practical solution of the broader aspects of extracting from our space effort the greatest possible contributions to human welfare within its sphere of influence. For its part NASA is attempting to give due consideration to its responsibility in these major questions of the social impact of the space program.

Document III-12

Document title: Edgar M. Cortright, Memorandum for Mr. Webb, "NASA-CIT/JPL Relations as they pertain to the present contractual arrangements of operating conditions and the future role of JPL in the NASA Program," June 1964.

Document III-13

Document title: Arnold O. Beckman, Chairman, Board of Trustees, California Institute of Technology, to James E. Webb, Administrator, NASA, June 26, 1964.

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

One of the persistent challenges faced by NASA managers in the agency's earliest years was the relationship with the California Institute of Technology's (Caltech, or CIT, as stated in Document III-12) Jet Propulsion Laboratory (JPL) in Pasadena, California. JPL had been established during World War II as a contractor facility developing rockets and other technologies for the U.S. Army. Since the war, it had expanded its capabilities, and by the time of NASA's establishment in 1958, JPL was a major location not only for the development of rocket technology but also space science. Because of this, NASA leaders secured the transfer of JPL from the Army and re-emphasized in the late 1950s a JPL effort already under way—Project Ranger, an effort to send satellites to the Moon. Following the failure of the Ranger 6 spacecraft in January 1964, NASA Administrator James E. Webb pressed Arnold O. Beckman, chair of the Caltech Board of Trustees, to alter the methodologies of management at JPL. These two documents describe this situation and propose changes. They successfully set in motion a number of activities that affected the relationship for more than a decade thereafter. Edgar Cortright was NASA's Deputy Associate Administrator for Space Science and Applications.

Document III-12

[1]

Memorandum for Mr. Webb

Subject: NASA-CIT/JPL Relations as they pertain to the present contractual arrangements of operating conditions and the future role of JPL in the NASA Program.

Although this memorandum is designed as a position paper it is necessary to review certain aspects of the history in working with Cal Tech and JPL.

I. History

A. Contract Provisions

The initial NASA contract placed in late 1959 with CIT for the operation and management of JPL was quite broad and free from constraint and provided for minimum control over the activities of the Lab. The current contract, executed in December 1961, reflects the experience gained in the two preceding years, of dealing with JPL, but still permits JPL considerable latitude for independent operation. This operating latitude results primarily from the necessity of mutual agreement between NASA and CIT/JPL on substantive changes in program or administration. During negotiation of the current contract, NASA officials suggested a change in the requirement for mutuality in certain aspects of JPL operation. However, this change was not successfully negotiated.

[2] B. JPL Assignments

Since the beginning of our working relationship with JPL, the Laboratory has been assigned functions in the areas of flight projects, deep space instrumentation, and supporting research and technology. Among the flight projects, the assignments have included Ranger (Blocks 1, 2, 3, 4, and 5), Mariners (A, R, C and B), Surveyor, Surveyor Orbiter (study phase), Voyager (study phase), and Prospector (study phase—cancelled). In addition, the launch vehicle, Vega, was assigned to JPL and subsequently cancelled. JPL has carried out the buildup of the deep space instrumentation facility on a worldwide basis. It has carried out research in fluid mechanics, structures, propulsion, electronics, telemetry guidance and control, and other areas, many of which were not covered at other NASA Centers. JPL has, through a master planning board initiated by NASA, undertaken to expand and upgrade the existing laboratory facilities for the Government.

C. JPL Organization

The JPL organization was originally structured as a research laboratory in propulsion fuels, materials, etc., and subsequently assigned one large project, e.g., Corporal, then Sergeant. This meant that research people were intermixed with project people; the laboratory was strictly a matrix organization and a loose one at that. With the assignment of multiple projects, JPL began a series of reorganizations. [3] Basically, they created a Systems Division to do systems engineering for all of the projects, and two program offices—the Lunar Program Office, and the Planetary Program Office. These program offices, the Systems Division, and all of the other laboratory divisions reported to the Director's office. The Program Offices contained the project managers with small staffs. To assist in the management of this matrix, Dr. Pickering [JPL Director] hired a Deputy Director (Brian Sparks). This early configuration has recently been modified to combine the two program offices into a single program office; to strengthen the coordination among projects, deep space instrumentation facility, research and development, and business administration; and to strengthen the reliability and quality assurance effort. Although the laboratory was not projectized, all employees working for the projects have been identified and fixed to a project. In brief then, the laboratory has moved in the direction of strengthening its project management and correcting its faults after they have become apparent to the laboratory. They still retain a matrix organization with many important individuals reporting to Pickering and Sparks directly and with project offices which are marginal in strength and quite dependent on strong front office leadership to insure a smoothly functioning total laboratory team.

[4] **II. NASA Direction**

Initially, NASA direction to JPL was almost exclusively from the Office of Space Flight Programs. With the advent of the NASA matrix organization JPL receives direction from many offices in Headquarters, e.g., OSS, OART, T&DA, Office of Programs, Procurement and Contracting, and the Office of Administration. The quality and depth of direction have varied from situation to situation and many have been inadequate to the situation existing within JPL on several occasions. The rapid growth of the laboratory of 2400 to 4000 has certainly contributed to developing problem areas. The rescheduling of projects necessitated by the Vega cancellation and the Centaur slippage have been serious perturbations. The overloading of the laboratory by NASA Headquarters and its own management had caused problems which might have been avoided if we had used better judgement [sic]. Lastly, the changing interface between JPL and NASA has caused communications problems and misunderstanding with regard to direction functions and authority.

III. Strength of CIT/JPL Performance

From the positive point of view, JPL represents a collection of highly imaginative and skilled engineers and technicians. This scientific and engineering team has been attracted to JPL, at least partially, because of the outstanding technical reputation of CIT. [5] They have shown considerable flexibility and have been able to roll with the number of reprogramming punches which have been forced upon them by circumstances. They have shown a keen interest in the space program and, despite frequent internal wranglings, they have never carried their arguments with NASA to the public. The working relationships have grown steadily better and excellent communications links exist among individuals in certain areas. The Project performance has generally been spotty, having varied from outstanding on Mariner to poor on Ranger. Similarly, the quality of business performance has varied ranging from excellent on source evaluation procedures used on Surveyor to inadequate administration of the resulting contract.

IV. Weaknesses of CIT/JPL Performance

In general, the performance of Cal Tech and JPL can be summarized as follows: Cal Tech has provided almost no visible leadership to JPL and has generally proven to be a poor communication link between NASA policy makers and JPL policy makers, e.g., at the DuBridge-Pickering level. Also lacking is action by the CIT Board of Trustees to clearly define the Institute's responsibility in the management of JPL, and to assign specific responsibility to designated positions or individuals. The CIT/JPL top leadership has been weak in terms of attention to substantive program issues in the [6] laboratory and in terms of responsiveness to official NASA guidance and direction. At times, the leadership has almost obstructionist. This has primarily been the case when NASA suggestions have been made with a view to improving laboratory management. The top management has consistently taken the attitude that the management of their laboratory is their business, and that unless the the contract terms specifically cover items discussed they have no interest in our compulsion to perform functions or take actions demanded by NASA managements [sic]. The most serious concern on the part of those of us doing business with the laboratory, however, has been the lack of involvement of the top management in direction of the day-to-day operations. The organization is structured so that it requires such involvement yet little or no evidence of such management direction is apparent. The members of the team operate much of the time with no apparent leadership. Many of the problems which JPL is now struggling to solve might have been avoided or at least recognized earlier had JPL management been more involved in the day-to-day execution of the major laboratory assignments or had they worked with NASA to correct those weaknesses detected and pointed up. One might say that it took the Ranger situation to make JPL face up to its many problems. I might add that NASA is having to face up to a few of its own by the same token.

[7] **V. Actions That Can Be Taken Prior to Contract Renewal**

Some of the things that can be done under the present arrangement for operation of JPL are:

1. The CIT Board of Trustees should, by formal action, define the responsibility of CIT for direction of JPL.
2. CIT should designate a top University official to whom NASA can direct its requests for corrective actions. This official should have clearly assigned authority to effect changes in all areas (management, technical, and business administration). In this regard, it may be desirable for NASA to offer to present its views to the CIT Board of Trustees.
3. An understanding should be reached whereby CIT/JPL will be responsive to NASA suggested changes in management and organization. For example, there is still a need for a strong General Manager at the Laboratory.
4. The "Task Order" problem should be resolved. The contract provides for separate task orders covering major NASA projects and these have not yet been negotiated.
5. The business management practices at JPL should be made compatible with NASA policies and practices. Examples of areas where business management practices can be improved are:
    a. Procurement policies and procedures
    b. Budget programming, financial management, and reporting systems

[8] c. Management of facilities property and supply
    d. Travel and other fringe benefit policies

VI. Alternatives for Consideration Before Present Contract Expires

Since the present contract expires December 31, 1964, it is not too early to think about the relationship of NASA-CIT/JPL after that date.

Several alternative arrangements are possible.

A. The contract could be allowed to expire and the Government owned Laboratory could be operated by civil servants.

Advantages

1. True center of NASA would operate under same NASA policies and regulations as other NASA Centers.
2. Problem of salary differential for similar work would disappear.
3. One echelon of management would be eliminated, i.e., CIT.

Disadvantages

1. Loss of effort and drive for some period while change takes place (6-12 months) Projects disrupted.
2. Loss of hardcore of key personnel—would probably move to industry.
3. NASA recruitment problem to be faced.

[9] 4. NASA public image problem.
   a. Cal-Tech
   b. Scientific community-industry
   c. Congressional
5. Loss of flexibility laboratory enjoys as contractor operated, e.g., not bound by all Government rules and regulations.

B. A non-profit corporation could be substituted for CIT/JPL management.

Advantages

1. Single purpose of Board of Directors. Minimizes possibilities of conflict of interest situations. Only serve one customer, NASA.
2. Provide NASA ability to have direct influence on management selected or replaced.
3. Provide flexibility of wage and fringe benefit allowances—not tied to campus scale or limitations.

Disadvantages

1. Project disruption while changes take place.
2. NASA public image problem.
3. Higher cost operation.
4. Magnification of differences between the Lab and other NASA Centers.

C. An industrial contractor could be selected to operate the Laboratory for the Government.

[10] *Advantages*

1. Initial selectivity from range of industrial capabilities.
2. Flexibility of industry management policies and practices.
3. Responsiveness to changes in direction or level of effort.

Disadvantages

1. Project disruption while changes take place.
2. NASA public image problem.
3. High cost operation.
4. Loss of relationship of Lab to other NASA Centers.
5. Possible conflict of interest situations.
6. Loss of active and direct control.

D. A form of the present contract with CIT/JPL could be continued if the following improvements can be worked out.

1. Clearly defined management responsibilities and accountability for CIT and JPL.
2. Clearly defined communication links between CIT-JPL-NASA Managements.
3. Acceptance of NASA contractor relationship by CIT/JPL.
4. JPL responsiveness to NASA direction and control.

   Advantages

   a. No major disruption to programs and projects.
   b. No major loss of hardcore key personnel.
   [11] c. No public image problem.
   d. No loss of flexibility of operating outside Government rules and regulations.

   Disadvantages

   a. Continued status of "almost NASA Center" concept.
   b. Continued problem of campus-off campus status.
   c. Management layer between lab and NASA-CIT.
   d. Conflight [sic] of interest situations.

VII. Summary

These observations on JPL and Cal Tech do not begin to tell the whole story, either good or bad. However, I think they can provide background for a position which is rather firm toward CIT in terms of demanding stronger management of the laboratory. In being fair, however, I think we can be responsible in terms of time required to implement some of the more radical changes we have suggested, such as hiring a general manager to supplement Pickering and Sparks or breaking up the Systems Division to strengthen the project offices. In reviewing our own judgements [sic], it might help to point out that these opinions of the laboratory are held rather widely throughout industry and among many of the JPL staff. The staff itself, I believe, hopes for continued NASA pressure which will result in stronger management by evolution rather then revolution. I consider it desirable that JPL continue in its past role of performing much the same function as a NASA center. The laboratory will be of most use to NASA if we can truly develop [12] the working relationships to make this possible.

Edgar M. Cortright

Document III-13

[1] June 26, 1964

Mr. James E. Webb
Administrator
National Aeronautics and Space Administration
Washington, D.C.

Dear Mr. Webb:

About three months ago, at a meeting in your office, we discussed the NASA-JPL-Caltech relations. This meeting was the first opportunity since I assumed the chairmanship of the Caltech Board of Trustees to hear directly from you and members of your staff about a number of problems related to JPL. I promised then to do everything possible to assist in eliminating the causes of past complaints, improve management operations at JPL in the light of suggestions made by your staff and others and attempt to find new ways in which NASA and Caltech could be mutually helpful in expanding fundamental research in space. Substantial progress has been made, I believe, and I thought you would be interested in hearing about it. In the following pages and attached appendices I have outlined briefly some of the highlights in the areas of management, technical coordination, and Caltech-JPL research activities.

Management

Prior to January 1, 1964 Price-Waterhouse management advisory services department had been retained to study the organizational structure of JPL. At my request, the McMurry Company was called in to evaluate the top dozen or more administrators at JPL, and to make an independent study of the organization. This work, performed personally by Dr. McMurry, has been completed.

One of Dr. McMurry's principal recommendations was the procurement of a new Deputy Director at JPL. A detailed job description was prepared and two leading executive recruiting firms were retained to find suitable candidates. Many candidates were screened, including persons recommended by Mr. Hilburn and others in NASA. We were very fortunate, we believe, in being able to secure General A. R. Luedecke, currently General Manager of the Atomic Energy Commission. I believe that General Luedecke is an extraordinarily fortunate choice. His experience in handling large operations in the Air Force and the AEC has given him an excellent background in governmental procedures and requirements. In addition to his demonstrated high level of competence, the fact that the AEC carries much, if not all, of its research and development through university-type contracts has given the General very valuable experience which especially qualifies him for the NASA-JPL-Caltech operation.

[2] Dr. McMurry's report recommends that certain organizational changes be made at JPL. He recommends, however, that these changes be made after a new Deputy Director has assumed his duties. In the meantime, several changes have already been made which should improve management.

In December of 1963, the Lunar and Planetary Projects at JPL were consolidated under Mr. R. J. Parks, who [was] appointed Assistant Laboratory Director for Lunar and Planetary Projects.

In February 1963 the Director of the Jet Propulsion Laboratory formed an Executive Council consisting of the Deputy Director, Assistant Laboratory Directors, and the Special Assistant for Advanced Technical Studies. This group will advise the Director on all major policy matters, develop long-range plans, and to recommend preferable courses of action relative to major Laboratory questions and problems.

JPL management has consolidated all quality assurance and reliability activities into one office, reporting directly to the Director/Deputy Director of the Laboratory. The chief of this office, Mr. Brooks Morris, has been delegated the responsibility for all quality assurance and reliability activities related to JPL projects and to evaluate the probable reliability of the designs and plans for Laboratory missions.

A Management Information Office has [been] established in March 1963 to provide accurate and timely information to JPL top management, and to the appropriate elements within NASA Headquarters.

As suggested by certain people in NASA Headquarters, the Laboratory had taken a very close, hard look at the advisability of modifying the matrix organization in favor of a strict project structure. The results of this review has been a high degree of projectizing within the technical divisions. The majority of the professional staff, working on the flight projects, have been assigned full time and their efforts restricted to specific projects. The management of JPL is continuing to move in this direction in the establishment of new projects, as well as in the strengthening of existing projects.

The Financial Management Division has been transferred. The manager of that division now reports to the Deputy Director, giving that office increased stature and authority in keeping with the Laboratory's growth, and the increased emphasis on fiscal and contractual activities.

The Procurement Division has been transferred. It now reports directly to the Deputy Director in order to provide more complete integration of the technical and managerial problems associated with the increasingly large procurement actions entered into by the Laboratory in carrying out NASA's projects.

The Technical Studies Office, headed by Dr. Homer J. Stewart, has been established to direct, coordinate and to originate all JPL advanced mission studies for the unmanned lunar and planetary exploration.

[3] To accommodate the increasing number of outside projects utilizing the DSIF and the JPL SFOF, an Assistant Laboratory Director has been appointed to head the Deep Space Network activities at JPL. Dr. Rechtin, who is in charge of this office, is responsible

for coordinating all Laboratory actions relative to the DSIF, SFOF and the JPL technical divisions in order to assure that project requirements are understood and met.

In January of this year, the Facilities Office was reorganized and given responsibility for developing the implementing [of] a technical and supporting facilities program that will provide those facilities required for the accomplishment of its assigned tasks and for coordinating and integrating the inputs from the JPL technical divisions and other sources into a single approved long-range master facilities plan.

The Laboratory has engaged the services of the Harbridge House organization to make additional detailed studies of the procurement process, and to recommend procedures and policies to be adopted by JPL in this area.

Internal audit groups reporting to CIT and to the top management of the Laboratory are being established to review and ascertain the degree to which Laboratory policies and procedures are being complied with in order to adequately inform management of need for corrective actions.

In addition to the organizational changes delineated above, which are aimed at strengthening the decision-making processes by which JPL conducts its affairs, the management of the Laboratory has requested a review of the Procurement Division operations by a panel of NASA procurement specialists and has responded to all suggestions offered by this group; the majority of the substantive recommendations have been carried out.

To insure that JPL will receive that best possible guidance and assistance from Caltech, two new and influential working committees, reporting to the Chairman of the Board of Trustees of the Institute, have been formed. This will bring the knowledge and experience of many business executives and scientists to bear on the problems concerning the tasks to be performed by the Jet Propulsion Laboratory.

A Trustees Committee composed of the Chairman of the Board, the President of the Institute and four other trustees has been established. They bring to the Committee a vast background of experience in the management of industrial organizations operating in the aerospace field.

[4] The members of the Trustees Committee are:

Dr. Arnold O. Beckman (Chairman)
President—Beckman Instruments, Inc.

Dr. Lee A. DuBridge
President—California Institute of Technology

Mr. John G. Braun
President—C. F. Braun & Co.

Mr. Thomas V. Jones
President—Northrop Corporation

Dr. Augustus B. Kinzel
Vice President, Research—Union Carbide Corp.

Mr. Herbert L. Hahn
Partner—Hahn & Hahn

Mr. William E. Zisch
President—Aerojet General Corporation

Mr. Robert B. Gilmore and Dr. William H. Pickering are ex officio and nonvoting members. This group has already met several times. Its principle role is that of advisor to the Laboratory top management on major policy matters, and to keep the Executive Committee and Board of Trustees of the Institute informed on important matters at the Laboratory.

A committee of appropriate facility members has also been formed to deal with the very important interrelationships between the academic and scientific staff of the Institute and the technical staff of the Laboratory. The membership of the Facility Committee is as follows:

Dr. Clark B. Millikan (Chairman)
Director—Graduate Aeronautic Laboratories
Dr. Robert F. Bacher
Provost
Dr. Norman Horowitz
Professor, Biology
Dr. Robert B. Leighton
Professor, Physics
Dr. Frederick C. Lindvall
Professor, Electrical & Mechanical Engineering
Dr. Robert P. Sharp
Professor, Geology
Chairman, Division Geological Sciences
Dr. William H. Pickering
Director, Jet Propulsion Laboratory

This committee is principally concerned with the technical problems in which the experience of the scientific and technical staff of the Institute can be of support to the Laboratory. It will meet frequently to review [5] activities at the Laboratory and the Campus, to provide the Director of JPL with advice and support on important technical decisions, and to arrange for the exchange of technical information and to advise on the selection of highly qualified scientific personnel at the Laboratory.

Mr. Robert B. Gilmore, Vice President for Business Affairs at Caltech, has submitted several reports to Mr. Hilburn, stating in some detail the corrective measures that have been taken upon the recommendations of the Army Audit Report number LA 64-581, date of issue February 26, 1964 entitled "Report on Financial Management and Related Operations for the Period Ended June 30, 1963." A brief summary of some of the principal items is attached as Appendix A to this letter.

Technical Problems

As you know, there has been some criticism of JPL concerning technical matters such as design features, quality control, and testing. Some have stated their opinion that JPL scientists have not been adequately responsive to suggestions made by others. Not all suggestions are necessarily good, of course. To assist JPL in evaluating suggestions and to make sure that JPL's technical problems will receive the attention of the best research people at Caltech, the Caltech-JPL Facility Committee referred to above meets from time to time. This group has given Dr. Pickering and his associates probably the best advice available today, in the respective fields of the committee members, on the suggestions and the recommendations in the Kelly and Hilburn reports. To the best of my knowledge, every technical suggestion that has been received by JPL has either been adopted or, if not adopted, sound reasons for the rejection have been given.

With respect to Ranger 7, I have been informed and believe there has been the utmost cooperation between JPL and NASA officials. So far as I know, JPL has performed every task and made every test that has been requested by Dr. Seamans, Dr. Newell and Mr. Cortright. I have been unable to find any indication of unresponsiveness or lack of cooperation on the part of JPL. If something less than complete agreement on technical matters existed in the past, that situation does not exist today.

Caltech-JPL Research Activities

I have been aware, and I heartily applaud, your great personal interest in expansion of basic research. The Institute certainly shares your interest and desires to do all it can to assist in the development of a vigorous research program, not only at Caltech but in other universities capable of carrying on fundamental research. To give me an idea of what Caltech is doing in research related to space, Dr. Bacher and the various [6] division chairmen at Caltech have provided the information that is attached as Appendices B through I. The following items are included:

A proposal dated April 18, 1962 for NASA support of research in certain fields of physics and astronomy. This report gives a broad outline of important fields of research in which Caltech and the Mount Wilson and Palomar Observatories are engaged, together with a specific recommendation for a 3-year research program. This has been brought up to date by the attached list of staff members, post-doctoral research fellows and graduate students now working in the various fields of research.

A proposal dated July 20, 1962 for pre-doctoral training grants for Caltech. This proposal covers work that would be carried on in the divisions of biology, chemistry and chemical engineering, engineering and applied sciences, geology, physics, mathematics and astronomy.

A proposal dated July 22, 1963 for pre-doctoral training grants for a 3-year period. This proposal is essentially a duplicate of the previous one, with certain added programs.

Extracts of memoranda given by the various division chairmen at Caltech, which contain information of direct interest. Your attention is called particularly to the special summer program which started June 22, 1964 with 36 students selected from institutions all over the country for an intensified course in problems of space technology.

I hope I haven't burdened you unduly with this rather lengthy letter. I feel that Caltech and JPL both have done excellent jobs in getting on top of their problems and in taking steps to insure that NASA will receive the type of managerial and technical competence and performance that it desires. I believe that most of the sources of annoyance in the past have been eliminated and that developments of the past three of four months, while not entirely to the liking of any of us, have actually resulted in a substantial improvement in understanding and in over-all operations.

If you would care to make any comments or suggestions, I should be pleased to receive them.

Cordially yours,

Arnold O. Beckman, Chairman
Board of Trustees

Document III-14

Document title: Raymond Einhorn and Robert B. Lewis, Memorandum to Mr. Hilburn, "Review of Purposes and Application of CIT Fee and Overhead for the JPL Contract," with summary of report, October 20, 1964.

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

One of the issues of contention in the NASA-Caltech relationship during the early 1960s was the fee Caltech (referred to below as "CIT") charged NASA for managing the Jet Propulsion Laboratory

(JPL). When the failure of the Ranger 6 spacecraft in January 1964 brought the terms of contract renewal into question, the management fee amount became a significant issue. Consequently, NASA Assistant Deputy Administrator Earl D. Hilburn instructed Audit Division Director Raymond Einhorn and Financial Management Division Director Robert B. Lewis to review the fee. The following memorandum discusses this investigation and transmits a lengthy, five-part report. Also included here is the summary from the larger, 41-page report that was used to provide information for the space agency's effort to reorient relations between the NASA Headquarters and JPL.

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[1]

Memorandum

October 20, 1964

TO: Mr. Earl D. Hilburn
FROM: Raymond Einhorn [initialed]
Robert B. Lewis [initialed]

SUBJECT: Review of Purposes and Application of CIT Fee and Overhead for the JPL Contract

In accordance with your request to us and your discussion with Mr. Robert Gilmore, we visited the California Institute of Technology to review a current statement of CIT's reasons for a management fee for the Jet Propulsion Laboratory contract, and how CIT applied the fee and other income received by the Institute. We also were to determine the kinds of indirect expense which CIT charged to the Jet Propulsion Laboratory contract, the amounts charged, and how reimbursements for these charges were applied by CIT. . . .

[2]

I. SUMMARY

1. CIT Refused to Discuss Fee

CIT was unwilling to discuss the reasons for requesting or paying a fee for the JPL operation. It thought it was inappropriate for NASA to ask about the application of the fee, inappropriate for CIT to give the information, and dangerous for NASA to have the information even if it should get it. Despite the recent discussions that have been held with NASA officials concerning the fee, we were informed that Dr. DuBridge could not present a list of reasons immediately since the statement had to be carefully drawn up and reviewed by CIT officials and the Board of Trustees. The statement probably will not be submitted until after modification 10 is signed, and apparently will not contain dollar or other measurement factors.

2. CIT Reasons for a Fee

We summarized in Section II of this report the reasons previously given by CIT for the fee, and have made comments based on our analyses. Of the reasons given, we believe only four are suitable for consideration: (1) the benefits which NASA derives from a competent technical team at JPL, attracted and retained by CIT's reputation and academic environment, and from the availability of eminent faculty scientists to advise and consult with the JPL technical team; (2) to compensate CIT for the risk of possible injury to its reputation and damage to the future of the Institute, due [3] to technical failures in JPL projects, which are beyond the control of CIT; (3) to provide a "buffer" or a reserve of funds to help absorb the economic shock of the loss of fee and campus overhead payments in the event the JPL contract expires; and (4) to assist in the current financing of higher campus costs, such as higher salaries and operation of expanded facilities caused by the operation of JPL.

These reasons should be re-evaluated by NASA and CIT. Presumably Dr. DuBridge's additional statement of CIT's fee reasons will be of assistance in accomplishing this evaluation. The assignment of dollar or other measurements to fee factors is difficult, except for the "buffer" and "higher campus cost" items. These two factors can be measured if CIT would cooperate in the effort.

Other factors given by CIT in support of a fee do not have merit, such as unallowable costs and intangible and other costs no longer recoverable under current cost principles prescribed by the Federal Government (see Section IV). In addition, it should be noted that several factors given to justify a fee relate to operations for which NASA is already paying a very large proportion of the costs.

3. Source and Application of CIT Funds

We are fairly certain that the fee is used to finance current CIT expenditures and to provide the "buffer" that CIT stated it would need in case of the expiration of the JPL contract. We also believe [4] it may be used to supplement the plant fund and other special purpose funds. We are also fairly certain that the "buffer" is included in CIT's income stabilization reserve, a general reserve established for the purpose of smoothing out the "peaks and valleys" in the Institute's income. Our analysis of CIT's financial statements confirms the fact that the reserve is broader than just for the "buffer."

The only information CIT was willing to provide on the overall source and application of its operating income is summarized in Section II. However, the statement gives little guidance on the application of the fee.

4. CIT Indirect Expenses

NASA pays CIT for about one-half of its general and administrative expenses and about 65% to 78% of all major categories of general and administrative expenses that are applicable to on and off campus activities. These expenses are summarized in Exhibit A and Paragraph 2 of Section III. Our analyses of these payments showed not only that the allocation basis of salaries and wages is not suitable in all instances, but that the benefits to the JPL contract do not in many instances flow in this direction. A review of data available in selected areas, such as the Office of the Comptroller, showed that the vast majority of the effort is for on campus activities rather than for the JPL contract. Studies by the Army Audit [5] Agency indicate that there are many general and administrative areas that will be questioned by the contracting officer and the auditors when the preliminary audit report is discussed with CIT officials in late December.

NASA also pays around 78% of the operation and maintenance expenses of the CIT administration buildings and a corresponding proportion of the use charge and depreciation on these buildings. To the extent that the allocation of general and administrative expenses to JPL is high, operation and maintenance expenses are correspondingly high.

For other categories of overhead, NASA pays small amounts related to JPL's usage of students and other educational facilities.

5. Practices of Other Agencies

We made a limited examination of the practices followed in similar contracts with respect to the payment of a fee, as described in Section V. The only university situations which appear to us to be truly comparable were the AEC contracts with the Universities of California and Chicago. In these cases, the AEC pays a management allowance which

AEC policy states may exceed a conservative estimate of indirect cost, provided the allowance is not greater than the lower of the university's overhead requests or the fee that would be payable to a commercial contractor operating a government-owned plant.
[6] It should be noted that as adjustments are contemplated or made in the amount of overhead paid to CIT there will be even greater pressure for a fee. CIT has stated that the sum of the overhead and fee is the payment it requests for the operation of the JPL contract, and that this payment can be measured only partially by assignments of cost incurred. The balance, however determined, is the price tag CIT places on the contributions it makes, including the privilege given to the Government of using the University to conduct research. . . .

Document III-15

Document title: Contract Briefing Memorandum: Contract NAS7-100 With California Institute of Technology, January 12, 1965.

Source: Jet Propulsion Laboratory Archives, California Institute of Technology, Pasadena, California.

In response to both NASA and congressional investigations following the failure of the first six Ranger spacecraft, NASA's relations with the Jet Propulsion Laboratory and Caltech underwent a difficult period in 1964 and 1965. As demonstrated in earlier documents, NASA leaders demanded a number of changes in the nature of the agency's relationship with both Caltech and JPL. Because the 1962 NASA-Caltech contract was due to expire in December 1964, contract renewal was contingent upon these changes. The result was a two-year extension to the 1962 contract (NAS7-100), but with a number of significant changes, which are documented in this briefing memorandum.

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[1] January 12, 1965

CONTRACT BRIEFING MEMORANDUM
Contract NAS7-100 With California Institute of Technology

A. General

1. Contract NAS7-100 was originally entered into effective January 1, 1962, between NASA and the California Institute of Technology for the performance of Research & Development activities at Jet Propulsion Laboratory. NAS7-100 continued the effort performed under NASW-6 which expired on December 31, 1962 and which was originally entered into on May 1, 1959 when NASA took over the facilities at JPL from the Department of the Army (Los Angeles Procurement District, Pasadena). The facility was then administered under Army Contract No. DA-04-495-ORD-18.

Total costs under NASW-6 approximated	$ 166,516,043.31
Total Obligations Under NAS7-100 to Date, Approximates	$ 776,183,640.01

2. NAS7-100 was scheduled to expire on December 31, 1964 and negotiations commenced in late 1963 and concluded in early 1964 for both a contract extension as well as desirable management changes to be effected both contractually and organizationally. During the latter part of 1964, CIT instituted many organizational changes, principal ones

included (1) the hiring of General A. R. Luedecke, (Ret) formerly with the Atomic Energy Commission and assigned him as Deputy Director of the Jet Propulsion Laboratory (actually as General Manager) and (2) projectizing its major programs from what was originally a matrix type organization. During this same period, NASA developed Task Orders, setting out for the first time in the almost five years since NASA started work at JPL the specific areas the programs to be covered in separately identifiable and funded Task Orders.

3. NASA Headquarters, satisfied that CIT had instituted mutually desirable changes, approved on December 16, 1964, a two-year extension to Contract NAS7-100 to expire on December 31, 1966. The extended contract, issued as modification No. 10 to NAS7-100, actually is a completely revised contract superseding in its entirety the terms and conditions of the original contract, as amended.

4. All contract management and monitoring activities are administered by the NASA Resident Office at JPL under the direction of the NASA Institutional Director, the Associate Administrator for Space Science and Applications.

[2] **B. NAS7-100 (mod. 10) Principal Provisions**

1. Scope of Work

a. Both NASA and the CIT have agreed that the Contractor shall perform only those specific tasks as may be designated in *unilaterally* issued Task Orders which fall within the following broad areas of activity:

(1) Exploring the moon and its environment and the planets and interplanetary space, including earth-based investigations and operations related thereto.

(2) Conducting (i) a program of supporting research and (ii) a program of advanced technical development, designed to make contributions to space science, technology, and exploration.

(3) Developing and operating the Deep Space Instrumentation Facility and Space Flight Operations Facility in support of NASA programs.

(4) Carrying out investigations and providing services in the field of aeronautics.

(5) Assisting NASA in the formulation and execution of its programs by providing NASA with technical advice, studies and reports of investigations.

(6) Providing technical direction or project management in connection with contracts for work falling within the broad areas defined above which are awarded by NASA to other contractors.

The principal change between the old contract and that part revised as indicated above is that NASA now may issue unilateral direction for CIT to perform within the areas noted whereas CIT had the right previously to reject NASA's directions or insist on changes before it would accept any specific task. The old provisions (commonly referred to as "mutuality") served to restrict the Government on the work or services it could demand of CIT and was the cause of much friction between technical counterparts of both NASA and JPL. It is believed that the present arrangement will prove more satisfactory and follows more closely the normal task order type contract which allows for unilateral issuance of task orders. The contract does include, however, a safeguard against the Government issuing technically unfeasible or otherwise unworkable tasks. The contractor has an obligation to advise the Contracting Officer, within 10 days, of any Task Order it (the Contractor) does not consider feasible. Such an occurrence, will, of course, be investigated by NASA.

b. If NASA desires any work performed by JPL which is not included in the broad areas agreed to, it will be issued in a Task Order which requires acceptance by CIT. This type of work is expected to be insignificant.

[3] c. Preliminary to the award of Modification No. 10 (the revised contract) both NASA and CIT have agreed upon the specific task orders to be issued to cover the work then in progress. Other than for a relatively few and minor tasks, all definitive task orders required to cover the work in progress prior to effective date of Modification 10, have now been issued and will be maintained on a current basis.

d. In addition to specific scopes of work included in separate Task Orders, there are also included provisions concerned with Technical Direction and Guidance, Operation of a Technical Plan, Reliability and Quality Assurance, Specific Reporting Requirements, Manpower Utilization Plans and Project Management Responsibilities—all of which are spelled out and included in contractual directions for the first time.

e. Concurrently with the issuance of Definitive Task Orders, NASA has negotiated with CIT and the contract has now been amended to provide for an "authorized manpower" clause. This clause permits the Contracting Officer, for the first time, to establish a manpower ceiling on the total number of persons which the Contractor may employ at JPL and provides a penalty in the form of disallowing costs of persons employed in excess of the ceiling. Under the old contract, although informed ceilings were established, they were usually exceeded without any penalty placed on the Contractor. The initial ceiling under the revised contract was established on October 31, 1964 as 4,275 persons. JPL reduced to 4,245 persons as of November 30, 1964 and to 4,225 persons as of December 31, 1964. The ceiling has been reduced to 4,100 by June 30, 1965, and to 4,000 by December 31, 1965. JPL is expected to be sustained at about 4,000 persons. Adequate controls have been established at our Resident Office at JPL to preclude JPL from exceeding its established ceiling. New work is being monitored through the Resident Office relative to adequacy of JPL manpower resources without disturbing the manpower ceiling.

2. Contract Resources

a. CIT must provide all of the management, personnel, labor and services necessary for performance of all work under the contract except that work which it is authorized to subcontract for. NASA furnishes or CIT acquires for the Government's account, all property, including facilities, necessary for performance of work under the contract. This includes all real and leased property at JPL and buildings authorized for construction by JPL and/or Army Corps of Engineers. Now, for the first time, all property of a facilities nature, including real estate, comes under the cognizance and control of a separate Facilities Contract and removes it from the Research and Development area under which it was formerly controlled.

b. The Facilities contract (No. NAS7-270(F)) provides for periodic reporting, control, protection and maintenance of the Government property as well as a vehicle for authorized new construction.

[4] 3. Reporting

a. Under the revised contract, CIT is obligated to furnish management, financial, technical, progress and other reports as the Contracting Officer may direct. Under the old contract each report had to be mutually agreed to be furnished before it could be placed into effect. Here again, "mutuality" has been removed to provide for prompt response from the Contractor. Under the revised Contract, however, CIT may initiate additional unclassified reports to disseminate scientific and technical knowledge to the scientific community. Distribution and costs of publication of such additional reports are furnished annually to the Contracting Officer for his review.

4. Fiscal and Other Management Requirements

a. CIT is required to segregate and separately maintain the costs of each Task Order and each program so that costs for each program are readily identifiable.

b. JPL's financial management system must be compatible with NASA's system including integration of the NASA Agency-wide coding structure. NASA-PERT and the NASA Financial Management Reporting System for cost type contracts have been imposed on JPL and its major subcontractors in implementation of an integrated time-cost management control and reporting system.

c. The Contractor is required to make maximum use of Department of Defense Audit and Administrative Services to preclude duplication of effort. Audit services are being utilized to the fullest extent. Property and Inspection Services performed by DOD Agencies are constantly being expanded to meet requirements. It is expected that proposed Defense Contract Administrative Services District when established in Los Angeles will be used to the maximum extent practicable.

d. The Contractor is required to submit annual budget estimates for the work it anticipates will be performed for each succeeding fiscal year of a particular program. Revised estimates will be also be furnished as program requirements change, are reduced or are increased. Periodic guidelines are furnished to CIT for use in projecting its estimates.

e. The usual "Limitations of the Government's Obligation" and "Estimated Cost" clauses limiting the Contractor's expenditures to funds allotted and estimated costs set forth in Task Orders are included in the contract to control unauthorized expenditures by the Contractor.

5. Allowable Costs

a. The allowability of all costs for purposes of determining amounts payable to the Contractor is determined by the cost principles set forth in [5] Part 3 of Section XV of the Armed Services Procurement Regulation applicable to Educational Institutions (negotiations with CIT will be accomplished to convert the ASPR reference to the appropriate part of NASA Procurement Regulation). The contract also lists specific items of direct costs for purposes of agreement on an "advance understanding" as to the allowability of certain costs by the Government. The types of costs listed are compatible with the ASPR Cost Principles.

b. The revised contract calls for negotiation of overhead rates to cover institutional indirect cost. These provisions follow the standard procedure for agreement on final overhead rates as contained in most Government cost-type contracts. The old contract provided for a fixed allowance for "indirect costs" which generally could not be changed. This was fixed after the beginning of the fiscal year regardless of the actual overhead expenditures which might be incurred during the year. The present procedure fixes rates only after the completion of the fiscal year and is based upon actual audited overhead expenditures. The present arrangement is more equitable to both parties.

6. Fixed Fee

a. A fixed fee is negotiated for each full fiscal year (or part of year included in term of contract) and the amount agreed upon is included in an amendment to the contract. The old contract did not provide any contractual incentive for raising or lowering the fee whereas the revised contract contains a schedule of fee ranges from a stated minimum to a maximum range according to the NASA approved Financial Operating Plan. The fee ranges are listed below:

Schedule of Fee Ranges

NASA Approved Financial Operating Plan		Fee Ranges	
		Minimum Fixed Fee	Maximum Fixed Fee
$	$	$	$
150,000,000	175,000,000	948,700.00	1,423,050.00
175,000,000	200,000,000	1,045,000.00	1,567,500.00
200,000,000	225,000,000	1,127,500.00	1,691,250.00
225,000,000	250,000,000	1,210,000.00	1,815,000.00
250,000,000	275,000,000	1,288,250.00	1,931,875.00
275,000,000	300,000,000	1,361,250.00	2,041,875.00
300,000,000	325,000,000	1,430,000.00	2,145,000.00
325,000,000	350,000,000	1,498,750.00	2,248,125.00

The basis for determining fee is the total JPL financial operating plan first approved by NASA following passage and approval of the NASA Appropriation Act for a particular fiscal year. Although the Plan may be [6] subsequently amended or revised, the fee remains unchanged and avoids any aspect of a cost-plus-percentage-of-cost situation. Within the range of a particular Financial Operating Plan, negotiations may then take place within the stated minimum and maximum ranges. Consideration is given by the Contracting Officer, among other factors, in negotiations, to:

(1) Extent of subcontracting
(2) Complexity of the work
(3) Past performance evaluations conducted under a new clause of the contract entitled "Evaluation of Contractor's Performance."

b. Using the current fiscal year (1965) for an example, the first approved Plan issued by the Contracting Officer, NASA Resident Office, totaled $216,195,000. This then falls within an operating plan range of $200,000,000 to $225,000,000 and a fee range of $1,127,500 to $1,691,250, which is subject to negotiations. The fixed fee negotiated for FY 1964 under the old contract amounted to $1,250,000.

7. Patent, New Technology and Related Clauses

The contract contains the appropriate Patents, New Technology, Data Rights and Licenses clauses prescribed by NASA Procurement Regulations. The NASA Resident Staff includes a qualified Patents Attorney who monitors all of the patent type activities of JPL.

8. Subcontracts

a. The contract contains provisions for review of selected subcontracts by the Contracting Officer to ensure compliance with good business practices, NASA Procurement Regulations and special requirements placed upon the Contractor.

b. All of the Contractor's procurement policies and procedures are subject to approval by the Contracting Officer. Included are Source Evaluation Board procedures which the Contractor has agreed to use for procurements in excess of $1,000,000.

c. The Contractor, by contract terms, has established and maintains a "Small Business Subcontracting Program" in accordance with current statutes and regulations. It is also obligated to include "Small Business Program" requirements in all of its subcontracts which offer substantial small business subcontracting opportunities.

[7] 9. Advance Payments

CIT is permitted to receive, on an interest-free basis, advance payments usually permitted in the case of Educational Institutions. The advance payments are sufficient to pay current payroll and operating costs. Under negotiation, however, is a letter-of-credit procedure designed to replace the advance payments provisions. This procedure has been promulgated by the U.S. Treasury Department and simplifies the advance payment process. Its primary advantage is to reduce the time that cash is in the hands of the Contractor and save Treasury the interest cost of idle money in the hands of a Contractor. This new procedure should be in effect shortly.

10. Safety and Plant Protection

The Contractor is obligated to maintain maximum safety conditions at all times and comply with applicable Federal, State and local laws and ordinances including Government regulations applicable to handling and storage of potentially dangerous fuels and propellants. CIT must also maintain plant protection devices, a security force and enforce applicable rules and regulations regarding Security and Classified matters. It must coordinate all Security matters with the cognizant Department of Defense Agency.

11. Equal Opportunities for Employment

The Contractor has agreed to comply with all nondiscrimination policies of the Government and administratively enforce compliance by its subcontractors.

12. Key Personnel, Wages and Salaries

a. Key personnel assigned to a particular program may not be reassigned without the consent of the NASA Headquarters Program Director.

b. CIT is obligated to keep the Contracting Officer fully informed as to JPL's wage and salary policies including notice of any action to an employee involving a rate of compensation in excess of $15,000 per annum.

13. General Services Administration Supply Services

Under the terms of the Contract, the Contracting Officer has required JPL to utilize GSA sources for any property which can be furnished from either warehouse stock or from GSA contractors. The use of this authorization has resulted in savings in procurement costs.

[8] 14. Non-Renewal of Contract

Appropriate provisions are made for the settlement of closing costs which might reasonably be expected to occur in the event NASA should decide not to further extend the contract.

15. Evaluation of Contractor's Performance

The revised contract includes provisions, for the first time, for the Government to evaluate the Contractor's (JPL's) performance both semi-annually and at the close of each fiscal year. An Evaluation Board will be composed of representatives appointed by the NASA Administrator. Conclusions will be reached after consideration of all the facts and after giving CIT the opportunity to submit such information and material as it desires. The conclusions reached by the Board will influence, in part, subsequent fee negotiations.

16. Government Property

The Contractor receives, issues, maintains and protects all Government property under its control, in accordance with NASA Procurement Regulations and the NASA Industrial Property Control Manual. The Contractor's activities in this area are continuously monitored by a NASA Property Administrator assigned to the NASA Resident Office Staff. Property in the control of subcontractors is monitored by DOD Agencies assigned secondary property administration.

17. Other Requirements

Other contract clauses required by statute or regulation are included in the contract.

Document III-16

Document title: Office of Technology Utilization, Task Force to Assess NASA University Programs, *A Study of NASA University Programs* (Washington, DC: NASA Special Publication-185, 1968), pp. 1-8.

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

Between 1962 and 1968, the NASA-university relationship expanded considerably. This document is the report of a task force assigned to review the totality of that relationship, which had resulted from NASA's attempt to use Apollo funding to effect a change in academic America. This report lent support to the decision to curtail drastically and eventually even to cancel the Sustaining University Program.

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[1] **Precis**

This study examines the results of the total NASA university program. It is an assessment of the program based on goals publicly expressed by NASA managers as recorded in the literature and correspondence with universities. Foremost among the goals has been the intent of NASA to accomplish its aeronautics and space mission while at the same time strengthening the universities involved; NASA-sponsored research was to be conducted in the traditional atmosphere of instruction and learning in order to maximize the indirect returns from the mission-oriented programs. The study was approached through selected sampling of NASA-university interactions by interviews, university visits, and in-depth case studies. The significant limitations of the study are those imposed by the lack of sufficient time to collect and analyze data on such a huge and diverse program. However, the Task Force believes this report to be indicative of the total NASA university program.

Impact on NASA, Universities, and the Nation

The returns from all NASA university programs fall into the categories of new knowledge, trained people, or new capability for research, education, and service. The major impact of these returns is upon the participants. However, since NASA and universities are both parts of the Nation, anything that affects them also affects the Nation. The results of programs that affect the Nation outside the immediate areas of the participants generally are too obscure to be identifiable. Therefore, the emphasis of this study is on the new knowledge, trained people, and new capability that have impacted NASA and universities and, through them, the Nation.

General.—NASA's university programs have made major contributions to the aeronautics and space program. Research sponsored by university programs has generated new concepts, has developed new technology, and has created unique facilities for further education and research. Over 50 percent of all experiments flown on NASA satellites have been generated by university programs. Universities have awarded at least 500 graduate degrees and provided continuing education opportunities to thousands through NASA employee graduate training programs. Even management of the aerospace program has been influenced, since university consultants have given policy, scientific, and engineering advice to NASA at all levels. These contributions demonstrate that NASA university programs have been successful in their first and most important objective—obtaining the expertise of the university community to help meet the aeronautics and space goals of NASA and the Nation.

NASA university programs have had a significant impact on the university community. About 250 universities have been responsive to opportunities to become involved in the aeronautics and space program made available by NASA. [2] They have welcomed NASA support and have used it to strengthen and build research and education capability. Centers of excellence exist that were created with NASA support. Entire departments and graduate degree programs have grown out of NASA involvement, many new courses have been developed, and countless science and engineering courses have had their content altered by NASA programs. The national capability for education and research has been both broadened and strengthened.

In general, universities have not taken advantage of the opportunities offered by NASA to innovate in research management, multi-disciplinary research, and government-industry-university relations. There is little evidence that the long-range goals of NASA university programs, such as the development of a university capability to respond as an institution, capability for multi-disciplinary research, concern with societal problems, and acceleration of technology transfer, are being achieved. The examples that were identified—an Urban Laboratory at UCLA, the Industrial Development Division at the University of Michigan, Cornell's new Department of Environmental Systems

Engineering, etc.—are only loosely tied to NASA programs. Sometimes they were unknown to, or unrecognized by, the scientists administering the NASA grants. It should be pointed out, however, that the dollars NASA has used to encourage change have come mostly from the Sustaining University research and facilities programs and have amounted to less than 1 percent of the total Federal support to universities. From this perspective, the changes that NASA university programs have stimulated in universities appear more significant.

NASA's university programs have built up a reservoir of good will within the university community toward the agency. University administrators generally perceive that NASA is sensitive to their needs and has undertaken a program to assist them with facilities, graduate student support, and institutional support grants. Generally, faculty members appreciate the opportunities for research and education that have been made available to them.

Industry has benefited from NASA university programs through the increased availability of trained people, new knowledge, and new capability. For the most part, however, industry-university relations do not appear to have been altered by NASA programs. Little evidence was found that universities were working harder at transferring technology to industry or have been successful in increasing industry support for university research.

Although NASA's stated policy is to conduct its programs in such a manner as not to draw faculty away from teaching, some of the research institutes, centers and laboratories in universities have very few graduate students involved in the ongoing research. Some have full-time staffs of research professionals who neither teach nor supervise graduate students. Most universities that have such special research groups are aware of the problem and are attempting to find mechanisms to bring research closer to the educational process. Some are successful; some are not. Significant numbers of groups with little educational involvement still exist. NASA violates its own policies when it supports groups that continue to divorce themselves from the educational function of the university.

[3] *Project research*—About 70 percent of NASA funds obligated to universities has been by the project research method. This system of supporting the research of principal investigators within universities is serving both NASA and the universities well. Abuse of the system sometimes occurs (e.g., overcommitment by an aggressive university researcher, demands for industrial-type response by a NASA contract monitor, or too little educational involvement). However, on balance, these are excellent programs that have contributed directly to the aerospace objectives of NASA. Project research also involves large numbers of faculty and graduate students and generates about three out of four of the space-science publications from all NASA programs. A large amount of education at all levels—undergraduate, graduate, and postdoctoral—is supported by these NASA programs. More than 10 percent of all funds supporting project research have been invested in equipment, which is available in university laboratories for further education and research.

Small project grants, which involve only one or two faculty members and their graduate students, have often led to productive interactions with NASA center personnel. Research on optimal control of nuclear rockets at the University of Arizona and ablation-material research at Louisiana State University are examples of projects through which NASA has received new concepts and techniques, the university has improved curricula and research and increased the number of publications, and technology is being transferred from universities to other segments of society. Larger project research grants, while producing valuable research, do not seem to foster development of as close a tie to the ongoing NASA program.

Space-science flight experimentation represents an area of significant accomplishment in NASA university programs. University scientists have been eager to take advantage of the opportunities made available by NASA to conduct experiments in space. More than 98 percent of balloon-borne experiments, more than 40 percent of sounding rocket experiments, and more than 50 percent of satellite experiments flown on NASA vehicles had principal investigators or coinvestigators in universities. For the satellite experiments, this is five times the level of participation of industry and about the same as the participation of all government laboratories. For the Orbiting Geophysical Observatory program alone, 50 percent of the flight experiments and almost two-thirds of the early scientific publications came from universities. A large share of the significant discoveries in space science were made in university-originated experiments.

Although the university community appears to have an effective voice in flight programs and selection of experiments through advisory committees, some university people complain about favoritism in the selection of flight experiments. Another continuing problem with university participation in flight experiments is involvement of graduate students. Long lead times and project uncertainties limit the suitability of flight programs for thesis projects. Universities have adopted various approaches to circumvent the difficulties, but NASA must continue to be aware of them and continue to seek administrative mechanisms that encourage participation of graduate students.

A university research program in R. & D. management and socioeconomics in aerospace-related areas has been NASA's only significant support of the social [4] science disciplines. This program has been quite productive as measured by publications and involvement of faculty and students. Capability for research on management of large technological programs has been created in several universities and is now available to the Nation. However, few if any management or policy decisions or processes within NASA appear to have been influenced by the research. While some of the research may have had potential usefulness, NASA has no mechanism for utilizing its results. The program has had no centralized direction or policy and almost no involvement of the centers where many management problems occur. It may be significant that NASA has sponsored a university research program in these disciplines without a corresponding in-house research capability—a position it has carefully avoided in engineering and physical-science disciplines.

Sustaining University Program.—The Sustaining University Program, which provided about 30 percent of NASA funds obligated to universities and provides support to institutions rather than to principal investigators within universities, has generally been successful. Its short-range objectives—increasing the supply of trained manpower, increasing university involvement in aeronautics and space, broadening the base of competence, and consolidating closely related activities—have been achieved. However, the long-range goals that require innovation and change by universities—capability for multidisciplinary research, university concern with the technology-transfer process, increased university involvement with community and societal problems, developing capability for institutional response—have not been successfully attained. There are a few indications of change in the direction of long-range goals that may lead to future developments.

The aims and operation of the Sustaining University Program are poorly understood within NASA outside the Office of University Affairs. Only in the Office of Space Science and Applications, which formerly directed the program, are they reasonably well understood and felt to have value to NASA as a supplement to project research. In other Headquarters offices and in the Centers, no benefit to NASA is seen in the program. The Sustaining University Program grants are viewed as giveaways to help universities. The quality of research sponsored by the program is regarded as not good enough to obtain support in open competition. The impact on both NASA and universities would have been greater if the in-house managers had been involved and committed to the programs.

The Sustaining University Program has made grants for multidisciplinary space-related research to 50 universities. These grants were about 10 percent of the total research funds provided to universities by NASA. The grants achieved the objective of broadening the base of involvement and capability in aerospace research. They have contributed to the establishment of new departments (e.g., aerospace engineering or space sciences) and strengthened old ones (e.g., astronomy). Capabilities were nourished that since successfully competed for research support from NASA project research and other Government agencies.

The multidisciplinary aspect of Sustaining University Program research grants has generally not been taken seriously by universities. The universities perceive the grants as institutional support in a conventional sense that does not require innovation in the administration of research. A contributing [5] factor to this attitude is the lack of "systems" administrators in universities with broad views of real-world problems and the capability for breaking problems into small subsystems for attack by individual researchers. A small amount of multidisciplinary research that involves physical and life scientists and engineers is supported, but little of it was initiated under the grants. Research involving individuals from multiple disciplines, including social sciences, jointly attacking a multidisciplinary problem is nonexistent.

NASA has encouraged universities to involve social scientists in their research with little response. The small amount of social-science involvement that does exist is usually on a subproject that does not interact with other research.

Many of the individual researchers supported by Sustaining University Program research grants have no direct contact with NASA. If they know their counterparts in NASA, it is only by chance. While some of the scientists and engineers relish independence, many would welcome closer relations with NASA peers. Examples of interactions in project research illustrate the benefits that close relations could have for both universities and NASA.

A Sustaining University Program research grant in a university gives a focus to its aeronautics and space program that is not present in universities without such a grant. The steering committee which administers the grant seems to give identity and visibility to the total NASA program. The existence of this committee appears to give credence to NASA's concern for doing its business in a way that strengthens the university and is a step toward interdepartmental cooperation for multidisciplinary research. Key members of these committees tend to dominate the direction of the program for the total university.

The Sustaining University Program predoctoral traineeship grants to 152 universities accounted for about 15 percent of total NASA obligations to universities and have supported more than a thousand students who have earned Ph.D. degrees in space-related areas. By 1970, over 4,000 doctorates will have been earned by trainees. More than half of these highly trained scientists and engineers are remaining in universities and will contribute to the Nation through education and research for years to come. About a third of the former trainees are seeking industrial careers. Many of their skills are transferable to areas other than aerospace and will continue to benefit society and science whether or not they engage in aerospace research. Some evidence exists that traineeship grants have accelerated (as well as increased) the production of doctorates, but it is not conclusive except in the obvious cases of students who otherwise would have held part-time jobs.

The trainees tend to be isolated from NASA and have little opportunity to identify with the Agency. Since the program is administered by the individual universities, not even the stipend checks come from NASA. The Agency has overlooked an opportunity to communicate with the students, which is reflected by the statistic that only 1 percent of the Ph.D. recipients have been hired by NASA. This indicates very little direct impact on

NASA by the traineeship program.

[6] The traineeship-grant program has had little impact on large established graduate schools. Ten or 12 additional traineeships tend to get lost in universities such as Cornell or Michigan. However, traineeships were awarded to 152 universities, most of whom [sic] do not have the size or reputation of the two universities just mentioned. The grants have enabled the smaller and less well established universities to recruit more and better graduate students and to strengthen their graduate education programs.

The Sustaining University Program has made 35 facilities grants to 32 universities that have already resulted in 27 completed laboratories. The grants account for over 6 percent of NASA obligations to universities. The facilities are enabling universities to participate in aerospace programs more effectively by providing working space and by consolidating aerospace-related activities. They are being used to house interdisciplinary activities, usually in the form of an aerospace-related institute, center, or laboratory. Little evidence was found that technology-transfer processes or university interaction with the local or regional community had been stimulated by the facilities visited.

Little evidence was found that the Memorandums of Understanding associated with Sustaining University Program facilities grants have led to anything but talk. Usually only a few administrators with a university even knew about the Memorandum. They had not attempted to use it as a tool to induce changes in procedures or attitudes; they did not regard it as requiring them to do anything new or different. The major criticism which must be made is that universities have not made "energetic and organized" efforts to implement the Memorandums, which they clearly agreed to do.

Personnel development programs.—The temporary in-residence faculty programs (NASA-ASEE [American Society of Electrical Engineers] summer faculty fellowships, NASA-NRC [National Research Council] resident research associates) are among the most rewarding of NASA university programs. NASA managers feel that the participants bring new talent and ideas into NASA projects and develop continuing relationships with NASA after they return to their schools. The participants like the programs for the exposure to real problems, for new ideas for research, and because they often provide a sponsor for their own research. Almost a thousand NASA-ASEE summer faculty fellows have spent 10 weeks during the summer working on real-world problems at a NASA center. More than 300 NASA-NRC postdoctoral research associates have had the opportunity to conduct research in a NASA center for at least 1 year. These programs have led to new research projects, curriculum modifications, and the creation of new centers of excellence. The acoustics program at North Carolina State University is just one outstanding example of impact on NASA, the university, and the Nation resulting from participation in these programs.

The employee training program has contributed in a major way to upgrading the capabilities of NASA personnel. Employees have earned about 400 master's degrees and 100 Ph.D. degrees by this method in recent years. Simultaneously, in meeting training needs, NASA centers have strengthened old departments and accelerated the creation of new departments in nearby universities. The graduate program in physics at the College of William and Mary is one example of stimulation of regional graduate-education capability to meet Langley Research Center's graduate training needs.

[7] **Alternatives for Future Consideration**

The results of the study suggested many changes in procedures, policies, or approaches that would lead to more effective university programs. Many of these involve operational details and have been called to the attention of appropriate NASA managers. Only those of broad scope and general interest will be discussed here.

A substantial portion of Government-supported R. & D. management research within the country has been sponsored by NASA. However, NASA is not reaping full benefit from it because there is no mechanism for translating research into applications. In physical-science and engineering disciplines, university researchers interface with research-oriented NASA personnel who know how to disseminate and use their results. In the R. & D. management area, university researchers interface with NASA management practitioners with whom the researchers have difficulty communicating. Research-oriented management-science groups within NASA would be one approach to improving utilization of the sponsored research.

The Memorandums of Understanding associated with facilities grants have been ineffective in accomplishing change. The facilities may be a permanent symbol and reminder of NASA support, but NASA loses all leverage once the grant is awarded. Memorandums of Understanding might be more effective in inducing change if used in conjunction with institutional or multidisciplinary grants that have a renewal feature. University administrators could then use the threat of failure of renewal to influence faculty. NASA has recently begun to experiment with Memorandums associated with research and training grants and their effectiveness should be carefully evaluated.

Many NASA-university interactions have demonstrated that synergism occurs when personnel are in close communication. The element of close working relations has been missing from research sponsored by the Sustaining University Program. Therefore, the benefits to both NASA and universities from this research would be increased by closer ties with ongoing NASA programs. Individual researchers in universities need to communicate with their NASA peers and university administrators need more data on real NASA problems for decision-making in allocating grant resources. Therefore, centers and program offices should be participants—not advisors—and share responsibility in administration of Sustaining University Program research grants.

The mechanisms that have been established for bringing university faculty into NASA on a temporary basis are valued highly by NASA managers and by the participating university people. It is noteworthy that equivalent mechanisms permit NASA employees to enter the university community on a short-term basis but are not widely known or used. Many highly qualified NASA scientists, engineers, and managers could make significant contributions to universities in research, education, and administration, as well as increase their own understanding of university problems, if mechanisms could be developed for them to spend 6 months or a year as active participants—not students—in university programs. Exchange programs between universities and NASA should be encouraged.

[8] Employee graduate-training programs should be considered as another method for meeting the Nation's need for highly educated scientists, engineers, and managers. Innovations in these programs could help offset the reduction in Ph.D. production that will come after 1970 as a result of decreases in Sustaining University Program traineeships. If the employee graduate-training programs could be expanded, NASA would benefit from the services of highly motivated and capable employees while at the same time giving them educational opportunities. In addition, if NASA's requirements for employee graduate training at nearby universities are large, financial support to the universities for facilities and faculty augmentation should be considered.

A requirement that annual reports on all grants and contracts summarize numbers of graduate students given full or partial support, theses supported, technical reports published, curriculum changes, facilities acquired, and degrees earned by students being supported would emphasize to universities NASA's desire to support research in an educational environment and would provide data to assess the program.

Continuous feedback on the effectiveness of university programs is needed by NASA management at all levels. A better management information system and reporting of educational impact of NASA programs would satisfy many requirements. However, periodic use of ad hoc groups, university consultants, and regularly scheduled conferences of the Office of University Affairs, Centers, and Program Offices will probably all be required.

Document III-17

Document title: Major General Samuel C. Phillips, USAF, Apollo Program Director, to J. Leland Atwood, President, North American Aviation, Inc., December 19, 1965, with attached: "NASA Review Team Report."

Document III-18

Document title: George E. Mueller, Associate Administrator for Manned Space Flight, to J. Leland Atwood, President, North American Aviation, Inc., December 19, 1965.

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

In late 1965, at the request of NASA Associate Administrator for Manned Space Flight George E. Mueller, Major General Samuel C. Phillips, Apollo Program Director at NASA Headquarters, initiated a review of NASA's contract with North American Aviation, Inc. (referred to as "NAA" below), to determine why work on both the Apollo spacecraft and Saturn V second stage was behind schedule and over budget. This highly critical study, known as the Phillips Report, took on added significance when in the aftermath of the Apollo 204 capsule fire (just over one year later), it was discovered that NASA Administrator James E. Webb was apparently unaware of the existence of the report. General Phillips provided a set of the notes which comprised the study to North American President J. Leland Atwood, and George Mueller added his views in a separate letter.

Document III-17

[1] IN REPLY REFER TO: MA December 19, 1965

Mr. J. L. Atwood
President
North American Aviation, Inc.
1700 E. Imperial Highway
El Segundo, California

Dear Lee:

I believe that I and the team that worked with me were able to examine the Apollo Spacecraft and S-II stage programs at your Space and Information Systems Division in sufficient detail during our recent visits to formulate a reasonably accurate assessment of the current situation concerning these two programs.

I am definitely not satisfied with the progress and outlook of either program and am convinced that the right actions now can result in substantial improvement of position in both programs in the relatively near future.

Enclosed are ten copies of the notes which was compiled on the basis of our visits. They include details not discussed in our briefing and are provided for your consideration and use.

The conclusion expressed in our briefing and notes are critical. Even with due consideration of hopeful signs, I could not find a substantive basis for confidence in future performance. I believe that a task group drawn from NAA at large could rather quickly verify the substance of our conclusions, and might be useful to you in setting the course for improvements.

[2] The gravity of the situation compels me to ask that you let me know, by the end of January if possible, the actions you propose to take. If I can assist in any way, please let me know.

Sincerely,

SAMUEL C. PHILLIPS
Major General, USAF
Apollo Program Director

[Attachment p.1]

NASA Review Team Report

I. Introduction

This is the report of the NASA's Management Review of North American Aviation Corporation management of Saturn II Stage (S-II) and Command and Service Module (CSM) programs. The Review was conducted as a result of the continual failure of NAA to achieve the progress required to support the objective of the Apollo Program.

The scope of the review included an examination of the Corporate organization and its relationship to and influence on the activities of S&ID [Space and Information Systems Division of North American], the operating Division charged with the execution of the S-II and CSM programs. The review also included examination of NAA off-site program activities at KSC and MTF [Mississippi Test Facility].

The members of the review team were specifically chosen for their experience with S&ID and their intimate knowledge of the S-II and CSM programs. The Review findings, therefore, are a culmination of the judgements [sic] of responsible government personnel directly involved with these programs. The team report represents an assessment of the contractor's performance and existing conditions affecting current and future progress, and recommends actions believed necessary to achieve an early return to the position supporting Apollo program objectives.

The Review was conducted from November 22 through December 6 and was organized into a Basic Team, responsible for over-all [2] assessment of the contractor's activities and the relationships among his organizational elements and functions; and sub-teams who [sic] assessed the contractor's activities in the following areas:

Program Planning and Control (including Logistics)
Contracting, Pricing, Subcontracting, Purchasing
Engineering
Manufacturing
Reliability and Quality Assurance.

Review Team membership is shown in Appendix 7.

Team findings and recommendations were presented to NAA Corporate and S&ID management on December 19.

II. NAA's Performance to Date—Ability to Meet Commitments

At the start of the CSM and S-II Programs, key milestones were agreed upon, performance requirements established and cost plans developed. These were essentially commitments made by NAA to NASA. As the program progressed NASA has been forced to accept slippages in key milestone accomplishments, degradation in hardware performance, and increasing costs.

A. S-II

1. Schedules

As reflected in Appendix VI key performance milestones in testing, as well as end item hardware deliveries, have slipped continuously in spite of deletions of both hardware and test content. The fact that the delivery [3] of the common bulkhead test article was rescheduled 5 times, for a total slippage of more than a year, the All System firing rescheduled 5 times for a total slippage of more than a year, and S-II-1 and S-II-2 flight stage deliveries rescheduled several times for a total slippage of more than a year, are indicative of NAA's inability to stay within planned schedules. Although the total Apollo program was reoriented during this time, the S-II flight stages have remained behind schedules even after this reorientation.

2. Costs

The S-II cost picture, as indicated in Appendix VI has been essentially a series of costs escalations with a bow wave of peak costs advancing steadily throughout the program life. Each annual projection has shown either the current or succeeding year to be the peak. NAA's estimate of the total 10 stage program has more than tripled. These increases have occurred despite the fact that there have been reductions in hardware.

3. Technical Performance

The S-II stage is still plagued with technical difficulties as illustrated in Appendix VI. Welding difficulties, insulation bonding, continued redesign as a result of component failures during qualification are indicative of insufficiently aggressive pursuit of technical resolutions during the earlier phases of the program.

[4] B. CSM

1. Schedules

A history of slippages in meeting key CSM milestones is contained in Appendix VI. The propulsion spacecraft, the systems integration spacecraft, and the spacecraft for the first development flight have each slipped more than six months. In addition, the first manned and the key environmental ground spacecraft have each slipped more than a year. These slippages have occurred in spite of the fact that schedule requirements have been revised a number of times, and seven articles, originally required for delivery by the end of 1965, have been eliminated. Activation of two major checkout stations was completed more than a year late in one case and more than six months late in the other. The start of major testing in the ground test program has slipped from three to nine months in less than two years.

2. Costs

Analysis of spacecraft forecasted costs as reflected in Appendix VI reveals NAA has not been able to forecast costs with any reasonable degree of accuracy. The peak of the program cost has slipped 18 months in two years. In addition, NAA is forecasting that the total cost of the reduced spacecraft program will be greater than the cost of the previous planned program.

[5] 3. Technical Performance

Inadequate procedures and controls in bonding and welding, as well as inadequate master tooling, have delayed fabrication of airframes. In addition, there are still major development problems to be resolved. SPS engine life, RCS performance, stress corrosion, and failure of oxidizer tanks has resulted in degradation of the Block I spacecraft as well as forced postponement of the resolution of the Block II spacecraft configuration.

III. NASA Assessment—Probability of NAA Meeting Future Commitments

A. S-II

Today, after 4 1/2 years and a little more than a year before first flight, there are still significant technical problems and unknowns affecting the stage. Manufacture is at least 5 months behind schedule. NAA's continued inability to meet internal objectives, as evidenced by 5 changes in the manufacturing plan in the last 3 months, clearly indicates that extraordinary effort will be required if the contractor is to hold the current position, let alone better it. The MTF activation program is being seriously affected by the insulation repairs and other work required on All Systems stage. The contractor's most recent schedule reveals further slippage in completion of insulation repair. Further, integration of manual GSE has recently slipped 3 weeks as a result of configuration discrepancies discovered during engineering checkout of the system. Failures in timely [6] and complete engineering support, poor workmanship, and other conditions have also contributed to the current S-II situation. Factors which have caused these problems still exist. The two recent funding requirements exercises, with their widely different results, coupled with NAA's demonstrated history of unreliable forecasting, as shown in Appendix VI, leave little basis for confidence in the contractor's ability to accomplish the required work within the funds estimated. The team did not find significant indications of actions underway to build confidence that future progress will be better than past performance.

B. CSM

With the first unmanned flight spacecraft finally delivered to KSC, there are still significant problems remaining for Block I and Block II CSM's. Technical problems with electrical power capacity, service propulsion, structural integrity, weight growth, etc. have yet to be resolved. Test stand activation and undersupport of GSE still retard schedule progress. Delayed and compromised ground and qualification test programs give us serious concern that fully qualified flight vehicles will not be available to support the lunar landing program. NAA's inability to meet spacecraft contract use deliveries has caused rescheduling of the total

Apollo program. Appendix VI indicates the contractor's schedule trends which cause NASA to have little confidence that the S&ID will meet its future spacecraft commitments. While our management review indicated that some progress is [7] being made to improve the CSM outlook, there is little confidence that NAA will meet its schedule and performance commitments within the funds available for this portion of the Apollo program.

[8] **IV. Summary Findings**

Presented below is a summary of the team's views on those program conditions and fundamental management deficiencies that are impeding program progress and that require resolution by NAA to ensure that the CSM and S-II Programs regain the required program position. The detail findings and recommendations of the individual sub-team reviews are Appendix to this report.

A. NAA performance on both programs is characterized by continued failure to meet committed schedule dates with required technical performance and within costs. There is no evidence of current improvement in NAA's management of these programs of the magnitude required to give confidence that NAA performance will improve at the rate required to meet established Apollo program objectives.

B. Corporate interest in, and attention to, S&ID performance against the customer's stated requirements on these programs is consider[ed] passive. With the exception of the recent General Office survey of selected functional areas of S&ID, the main area of Corporate level interest appears to be in S&ID's financial outlook and in their cost estimating and proposal efforts. While we consider it appropriate that the responsibility and authority for execution of NASA programs be vested in the operating Division, this does not relieve the Corporation of its responsibility, and accountability to NASA for results. [9] We do not suggest that another level of program management be established in the Corporate staff, but we do recommend that the Corporate Office sincerely concern itself with how well S&ID is performing to customer requirements and ensure that responsible and effective actions are taken to meet commitments.

C. Organization and Manning

We consider the program organization structure and assignment of competent people within the organization a prerogative of the manager and his team that have been given the program job to do. However, in view of what we consider to be an extremely critical situation at S&ID, one expected result of the NASA review might be the direction of certain reorganizations and reassignments considered appropriate, by NASA, to improve the situation. While we do have some suggestions for NAA consideration on this subject, they are to be accepted as such and not considered directive in nature. We emphasize that we clearly expect NAA/S&ID to take responsible and thoroughly considered actions on the organization and assignment of people required to accomplish the S-II and CSM Programs. We expect full consideration, in this judgement [sic] by NAA, of both near and long term benefits of changes that are made.

Frankly stated—we firmly believe that S&ID is overmaned and that the S-II and CSM Programs can be done, and done better, with fewer people. This is not to suggest that an arbitrary [10] percentage reduction should be applied to each element of S&ID, but we do suggest the need for adjustments, based on a reassessment and clear definition of organizational responsibilities and task assignments.

It is our view that the total Engineering, Manufacturing, Quality, and Program Control functions are too diversely spread and in too many layers throughout the S&ID organization to contribute, in an integrated and effective manner, to the hard core requirements of the programs. The present proliferation of the functions invites non-contributing, "make-work" use of manpower and dollars as well as impediments to program progress.

We question the true strength and authority of each Program Manager and his real ability to be fully accountable for results when he directly controls less that 50% of the manpower effort that goes into his program. This suggests the need for an objective reappraisal of the people and functions assigned to Central versus Program organizations. This should be done with full recognition that the Central organization's primary reason for existence is to support the requirements of the Program Managers. Concurrently, the Program Manager should undertake a thorough and objective "audit" of all current and planned tasks, as well as evaluate the people assigned to these tasks, in order to bring the total effort down to that which truly contributes to the program.

[11] It is our opinion that the assignment of the Florida Facility to the Test and Quality Assurance organization creates an anomaly since the Florida activities clearly relate to direct program responsibilities. We recognize that the existence of both CSM and S-II activities at KSC may require the establishment of a single unit for administrative purposes. However, it is our view that the management of this unit is an executive function, rather than one connected with a functional responsibility. We suggest NAA consider a "mirror image" organizational relationship between S&ID and the Florida operation, with the top man at Florida reporting to the S&ID President and the two program organizations reporting to the S&ID Program Managers.

D. Program Planning and Control

Effective planning and control from a program standpoint does not exist. Each organization defines its own job, its own schedules, and its own budget, all of which may not be compatible or developed in a manner required to achieve program objectives. The Program Managers do not define, monitor, or control the interfaces between the various organizations supporting their program.

Organization—S&ID's planning and control functions are fragmented; responsibility and authority are not clearly defined.

[12] Work Task Management—General Orders, task authorizations, product plans, etc., are broad and almost meaningless from a standpoint of defining end products. Detailed definitions of work tasks are available at the "doing level"; however, these "work plans" are not reviewed, approved, or controlled by the Program Managers.

Schedules—Each organization supporting the programs develops its own detailed schedules; they are not effectively integrated within an organization, nor are they necessarily compatible with program master schedule requirements.

Budgeting System—Without control over work scope and schedules, the budget control system cannot be effective. In general, it is an allocation system assigning program resources by organizations.

Management Reports—There is no effective reporting system to management that evaluates performance against plans. Plans are changed to reflect performance. Trends and performance indices reporting is almost nonexistent.

E. Logistics

The CSM and S-II Site Activations and Logistic organizations are adequately staffed to carry out the Logistics support. The problems in the Logistics area are in arriving at a mutual agreement, between NAA and NASA, clearly defining the tasks required to support the programs. The areas requiring actions are as follows:

[13] 1. Logistics Plan
2. Maintenance Manuals
3. Maintenance Analysis
4. NAA/KSC Relationship
5. Common and Bulk Item Requisitioning at KSC
6. Review of Spare Parts, Tooling, and Test Equipment Status

F. Engineering

The most pronounced deficiencies observed in S&ID Engineering are:

1. Fragmentation of the Engineering function throughout the S&ID organization, with the result that it is difficult to identify and place accountability for program-required Engineering outputs.
2. Inadequate systems engineering job is being done from interpretation of NASA stated technical requirements through design release.
3. Adequate visibility on intermediate progress on planned engineering releases is lacking. Late, incomplete, and incorrect engineering releases have caused significant hardware delivery schedule slippages as well as unnecessary program costs.

[14] 4. The principles and procedures for configuration management, as agreed to between NAA and NASA, are not being adhered to by the engineering organizations.

G. Cost Estimating

The "grass roots" estimating technique used at S&ID is a logical step in the process of arriving at program cost estimates and developing operating budgets. However, there are several aspects of the total process that are of concern to NASA:

1. The first relates to the inadequate directing, planning, scheduling, and controlling of program work tasks throughout S&ID. While the grass roots estimates may, in fact, represent valid estimates (subject to scrubbing of "cushion") of individual tasks by working level people, we believe that the present deficiencies in Planning and Control permit, and may encourage, the inclusion in these estimates of work tasks and level of efforts that are truly not required for the program.
2. The second concern is that the final consolidation of grass roots estimates, developed up through the S&ID organization in parallel through both Central functional and Program organizations, does not receive the required [15] management judgements [sic], at successive levels for (a) the real program need for the tasks included in the estimate, or (b) adequate scrubbing and validation of the man-hours and dollars estimates.

3. The third concern, which results from 1 and 2 above, is that the final estimate does not represent, either in tasks to be done or in resources required, the legitimate program requirements as judged by the Program Manager, but represents total work and dollars required to support a level of effort within S&ID.

Several recommendations are made in the appended reports for correcting deficiencies in the estimating process. The basic issue, however, is that an S&ID Management position must be clearly stated and disciplines established to ensure that the end product of the estimating process be only those resources required to do necessary program tasks. In addition, the Program Management must be in an authoritative position that allows him to accept, reject, and negotiate these resource requirements.

H. Manufacturing Work Force Efficiency

There are several indications of less than effective utilization of the manufacturing labor force. Poor workmanship is evidenced by the continual high rates of rejection and MRB actions which result in rework that would not be necessary if the workmanship [16] had been good. This raises a question as to the effectiveness of the PRIDE program which was designed to motivate personnel toward excellence of performance as a result of personal responsibility for the end product. As brought out elsewhere in this report, the ability of Manufacturing to plan and execute its tasks has been severely limited due to continual changing engineering information and lack of visibility as to the expected availability of the engineering information. Recognizing that overtime shifts are necessary at this time, it is our view that strong and knowledgeable supervision of these overtime shifts is necessary, and that a practical system of measuring work accomplished versus work planned must be implemented and used to gauge and to improve the effectiveness of the labor force. The condition of hardware shipped from the factory, with thousands of hours of work to complete, is unsatisfactory to NASA. S&ID must complete all hardware at the factory and further implement, without delay, an accurate system to certify configuration of delivered hardware, properly related to the DD 250.

I. Quality

NAA quality is not up to NASA required standards. This is evidence[d] by the large number of "correction" E.O.'s and manufacturing discrepancies. This deficiency is further compounded [17] by the large number of discrepancies that escape NAA inspectors but are detected by NASA inspectors. NAA must take immediate and effective action to improve the quality of workmanship and to tighten their own inspection. Performance goals for demonstrating high quality must be established, and trend data must be maintained and given serious attention by Management to correct this unsatisfactory condition.

J. Following are additional observations and findings that have resulted from discussions during the Review. Most of them are covered in most detail in the appended sub-team reports. They are considered significant to the objective of improving NAA management of our programs and are therefore highlighted in this section of the report:

1. S&ID must assume more responsibility and initiative for carrying out these programs, and not expect step-by-step direction from NASA.
2. S&ID must establish work package management techniques that effectively define, integrate, and control program tasks, schedules, and resource requirements.

3. S&ID must give concurrent attention to both present and downstream tasks to halt the alarming trend of crisis operation and neglect of future tasks because of concentration on today's problems.
4. A quick response capability must be developed to work critical "program pacing" problems by a short-cut route, with follow-up to ensure meeting normal system requirements.

[18] 5. S&ID must maintain a current list of open issues and unresolved problems, with clear responsibility assigned for resolving these and insuring proper attention by Program and Division Management.
6. Effort needs to be applied to simplify management systems and end products. There must be greater emphasis on making today's procedures work to solve today's problems, and less on future, more sophisticated systems. The implementation and adherence to prescribed systems should be audited.
7. NAA must define standards of performance for maintaining contracts current then establish internal disciplines to meet these standards. Present undefinitized subcontracts and outstanding change orders on the S-II prime contract must be definitized without delay.

CONCLUSIONS AND RECOMMENDATIONS

The NASA Team views on existing deficiencies in the contractor's management of the S-II and CSM Programs are highlighted in this section of the report and are treated in more detail in the appended sub-team reports. The findings are expressed frankly and result from the team's work in attempting to relate the end results we see in program conditions to fundamental causes for these conditions.

[19] In most instances, recommendations for improvement accompany the findings. In some cases, problems are expressed for which the team has no specific recommendations, other than the need for attention and resolution by NAA.

It is not NASA's intent to dictate solutions to the deficiencies noted in this report. The solution to NAA's internal problems is both a prerogative and a responsibility of NAA Management, within the parameters of NASA's requirements as stated in the contracts. NASA does, however, fully expect objective, responsible, and timely action by NAA to correct the conditions described in this report.

It is recommended that the CSM incentive contract conversion proceed as now planned.

Incentivization of the S-II Program should be delayed until NASA is assured that the S-II Program is under control and a responsible proposal is received from the contractor.

Decision on a follow-on incentive contract for the CSM, beyond the present contract period, will be based on contractor performance.

It is recommended that NAA respond to NASA, by the end of January 1966, on the actions taken and planned to be taken to correct the conditions described in this report. At that time, NAA is also to certify the tasks, schedules, and resource requirements for the S-II and CSM Programs.

[20] It is further recommended that the same NASA Review Team re-visit NAA during March 1966 to review NAA performance in the critical areas described in this report.
