

3

Address by

Dr. George E. Mueller
Associate Administrator for Manned Space Flight
National Aeronautics and Space Administration

before the

British Interplanetary Society
University College
London, England

August 10, 1968 7:00 p.m.

AS DELIVERED

...es show that using today's hardware, the resupply cost for a single three-man orbital space station for a year equals the original cost of the space station. This type of cost analysis has led us to carefully evaluate concepts for more efficient resupply systems.

Manufacturing in space, fuel and supply storage for deep space operations, life support for crews on board space stations, require not tons, but thousands of tons of material, to be shuttled in and out of space.

Therefore, there is a real requirement for an efficient earth to orbit transportation system -- an economical space shuttle. This need has been under study by long range aerospace planners for over a decade. The objective of these investigations is to find a design that will yield an order of magnitude reduction in operating costs. The elements to which we must look for cost reductions are, aircraft manufacturing techniques, aircraft development test procedures, maximum flexibility for multiple use and volume production, long life components for repetitive reuse, and airline maintenance and handling procedures for economy of operation.

The desirable operating characteristics of a space shuttle which would satisfy the needs which have been described are listed on this chart, (Figure 5). The shuttle ideally would be able to operate in a mode similar to that of large commercial air transports and be compatible with the environment of major airports.

It would take off vertically as shown in this concept, (Figure 6), from a small pad at an airbase or major airport.

Crews similar in size to those required for intercontinental jet dispatch would service the craft for launch.

The space shuttle, upon its return from orbit, would reenter the atmosphere and glide to a runway landing, with practically no noise. The landing would be completely automated with prime dependence upon the spacecraft guidance system but with ground control backup.

Cryogenic tank trucks containing liquid oxygen and liquid hydrogen would refuel the craft on its pad. Seven years of accident-free experience in handling cryogenic fuels have advanced this technology to practical safety. These non-toxic fuels are 10 times more powerful than gasoline and have demonstrated their efficiency.

The cockpit of the space shuttle would be similar to that of the large intercontinental jet aircraft, containing all instrumentation essential to complete on-board checkout, as shown in this illustration (Figure 7).

Programmable automatic equipment would perform the systems and subsystems tests necessary for take-off and flight support. Malfunction detection would be automatic.

I assume that continental and intercontinental air traffic control centers will have been established so that the space shuttle could take its place in the air traffic and space traffic patterns under these controls.

Interestingly enough, the basic design described above for an economical space shuttle from earth to orbit could also be applied to terrestrial point-to-point transport.

If the space shuttle were used as a global transport for point-to-point traffic in military, commercial or cargo service, its safety and comfort standards could be comparable to those of large transport jets.

The economics of the space shuttle must be evaluated in comparison with today's means of accomplishing similar missions.

Until now it has been essential to optimize space transportation systems on the basis of performance. Only a decade ago, technology was pushed to its limits in order to barely achieve orbital flight. Our first Vanguards and Explorers cost in the order of \$1,000,000 per pound of payload to fly into space. The next chart (Figure 8) illustrates the economy achieved by the Saturn V, which delivers payload at a cost roughly 3 orders of magnitude less than Explorer I. Extrapolating, we could reasonably expect a cost reduction of at least another order of magnitude, given the will to accomplish it, with present techniques.

If, however, the development of a space shuttle such as I have described were implemented, it seems that a reduction in cost by two orders of magnitude is achievable.

COMPARITIVE PROGRAM ACCOMPLISHMENTS

MILESTONES	MAXIMUM PACE	PROGRAM I	II, III	LOW LEVEL
<u>MANNED SYSTEMS</u>				
Space Station (Earth Orbit)	1975	1976	1977	-
50-Man Space Base (Earth Orbit)	1980	1980	1984	-
100-Man Space Base (Earth Orbit)	1985	1985	1989	-
Lunar Orbiting Station	1976	1978	1981	-
Lunar Surface Base	1978	1980	1983	-
Initial Mars Expedition	1981	1983	II - 1986 III - Open	-
<u>Space Transportation System</u>				
Earth-to-Orbit	1975	1976	1977	-
Nuclear Orbit Transfer Stage	1978	1978	1981	-
Space Tug	1976	1978	1981	-
<u>Scientific</u>				
Large Orbiting Observatory	1979	1979	1980	-
High Energy Astron. Capability	1973	1973	1981	1973
Out-of-Ecliptic Survey	1975	1975	1978	1975
Mars-High Resolution Mapper	1977	1977	1981	1977
Venus-Atmospheric Probes	1976	1976	Mid-80's	1976
Multiple Outer Planet "Tours"	1977-79	1977-79	1977-79	1977-79
Asteroid Belt Survey	1975	1975	1981	1975
<u>Applications</u>				
Earliest Oper. Earth Resource System	1975	1975	1976	1975
Demonstration of Direct Broadcast	1978	1978	Mid-80's	1978
Demonstration of Navigation/Traffic Control	1974	1974	1976	1974

TABLE 4-3. - NOMINAL SPACE SHUTTLE TRAFFIC MODEL

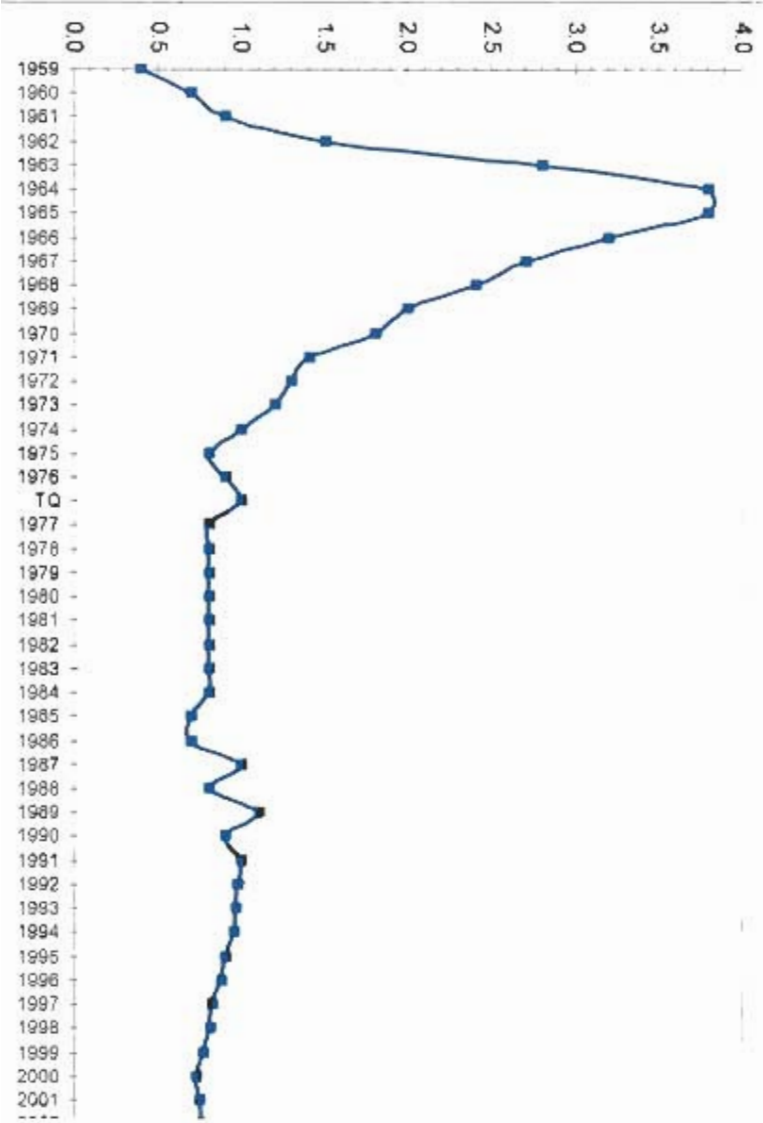
Program year	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
<u>Space Station</u> 12 men, rotate entire crew per quarter	7	7	7	7	7						
<u>Space Base</u> 50 men, rotate entire crew per quarter (10 men/flight)						23	23	23	23	23	23
<u>Unmanned planetary</u>	7	1	8	3	4	6	5	2	7	5	3
<u>Unmanned satellites</u>	2	2	2	2	2	2	2	2	2	2	2
<u>Lunar Program</u> 6-man orbital station and 6-man base				48	48	34	34	34	34	34	34
Total Space Shuttle flights/year	16	10	17	60	61	65	64	61	66	64	62

THE NIXON SPACE DOCTRINE

“We must think of (space activities) as part of a continuing process...and not as a series of separate leaps, each requiring a massive concentration of energy. Space expenditures must take their proper place within a rigorous system of national priorities. . . . What we do in space from here on in must become a normal and regular part of our national life and must therefore be planned in conjunction with all of the other undertakings which are important to us.”

–President Richard M. Nixon, March 7, 1970

NASA Budget as a Percentage of Federal Budget





NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICE OF THE ADMINISTRATOR

~~LIMITED ACCESS~~
~~DO NOT REPRODUCE~~

September 30, 1970

*Space Station
Project*

Honorable George P. Shultz
Director
Office of Management and Budget
Washington, D. C. 20503

Dear Mr. Shultz:

The purpose of this letter is to transmit the FY 1972 budget recommendations for the National Aeronautics and Space Administration and to set forth the major considerations which influenced their development.

The budget, to carry out our recommendations, will require \$3.688 billion in budget authority. The outlays required in FY 1972 are \$3.4 billion--essentially equal to FY 1971 but \$196 million over the FY 1972 budget target provided in your guideline letter of August 7, 1970. In accordance with your instructions, we have identified the actions which would be required if outlays must be limited to the target level.

Key Considerations

The key considerations which have led to our recommendations and which, in our view, should guide your review and the President's decisions on the NASA FY 1972 budget are as follows:

1. The United States now has clear leadership in space and aeronautics, as evidenced for example by Apollo; our Mars missions, our scientific, communications and weather satellites, and the dominant position of U.S. commercial aircraft. This position, we believe, should be maintained.
2. Our leadership is under continual challenge by a capable and determined competitor, as evidenced for example by Luna 16, continuing USSR manned flight activity, an increased Soviet launch rate while ours is decreasing, and advanced aeronautical designs of very high quality.
3. The sharp and substantial reductions in U.S. efforts in aerospace research and development work of the past several years have seriously diminished national capabilities and unless the trend is reversed our leadership position will be seriously called into question in the years ahead. There have been drastic reductions in the total industry employment on NASA work, while at the same time there has been a major cutback on military aerospace work--and there is a clear possibility that one or more major aerospace firms may be forced out of business.

~~LIMITED ACCESS~~
~~DO NOT REPRODUCE~~

This loss of capability must be recognized as a major national concern, affecting not only our future leadership role in aeronautics and space, but also the long-term strategic and economic position of the United States.

4. We now have--in the President's statement on the future of the space program of March 7, 1970--a clear set of goals and objectives for the space program of the 1970's. We can move forward, as envisaged in his statement, with a bold and balanced program with the three general purposes of exploration, scientific knowledge, and practical application directed at the six specific objectives he stated:

- a. Continued exploration of the moon,
- b. Exploration of the planets and the universe,
- c. Reduce substantially the cost of space operations,
- d. Extend man's capability to live and work in space,
- e. Hasten and expand practical applications of space technology, and
- f. Encourage greater international cooperation in space.

Although not specifically mentioned in the President's statement, we have also developed an aeronautics program for the 1970's--a program that will provide for continued U.S. leadership in civil and military aviation.

5. In recognition of current and longer term fiscal restraints, we have curtailed existing FY 1971 programs and adjusted the time-phasing of the future programs to avoid commitments to excessive funding levels in 1972 and future years. Our recent decisions to cancel two Apollo flights result in substantially lower expenditures than previously projected through FY 1974. Our decision not to proceed with the simultaneous development of the space station and space shuttle, and to defer until later in the 1970's the actual development of the post-Skylab space station, removes one of the principal causes of an unacceptable peaking of the NASA budget at over \$5 billion in the middle 1970's. As a result of these and other actions, we are now able to present and recommend an FY 1972 program which enables us to move toward each of the objectives in the President's statement without committing the nation to an annual NASA budget level in excess of \$4 billion.

6. The key element in our program for the 1970's is the space shuttle. It supports the last four of the President's six objectives.

~~LIMITED ACCESS~~
~~DO NOT REPRODUCE~~

Observatory (HEAO) to obtain high quality data on X-ray, gamma-ray, and cosmic-ray sources in space. In addition, studies will begin on future HEAO satellites and large space telescopes to be carried into space by the space shuttle in the last half of the decade. The HEAO and large space telescope projects have a top priority for the exploration of the universe beyond the planets.

3. Reduce substantially the cost of space operations - The space shuttle will be used for manned and man-tended experiments and to place unmanned scientific, weather, earth resources and other satellites in earth orbit and bring them back to earth for repair and reuse. In the future the space shuttle will also transport men, supplies, and scientific equipment to and from space stations. Through reusability, the space shuttle system will have a recurring operating cost per mission substantially lower than the cost of current systems. Of even greater significance from a cost standpoint, major reductions will be possible in the cost of scientific and applications programs because of the relaxation of size and weight constraints and the capability for recovery, repair and reuse of payloads.

We will be ready to proceed in FY 1972 on a realistic schedule with detailed design and initial development efforts which we estimate will lead to the first horizontal test flights in 1975. The first vertical flight would take place in 1977 with a manned orbital flight test possible by the end of that year, leading to an initial operating capability in the 1978/1979 time period.

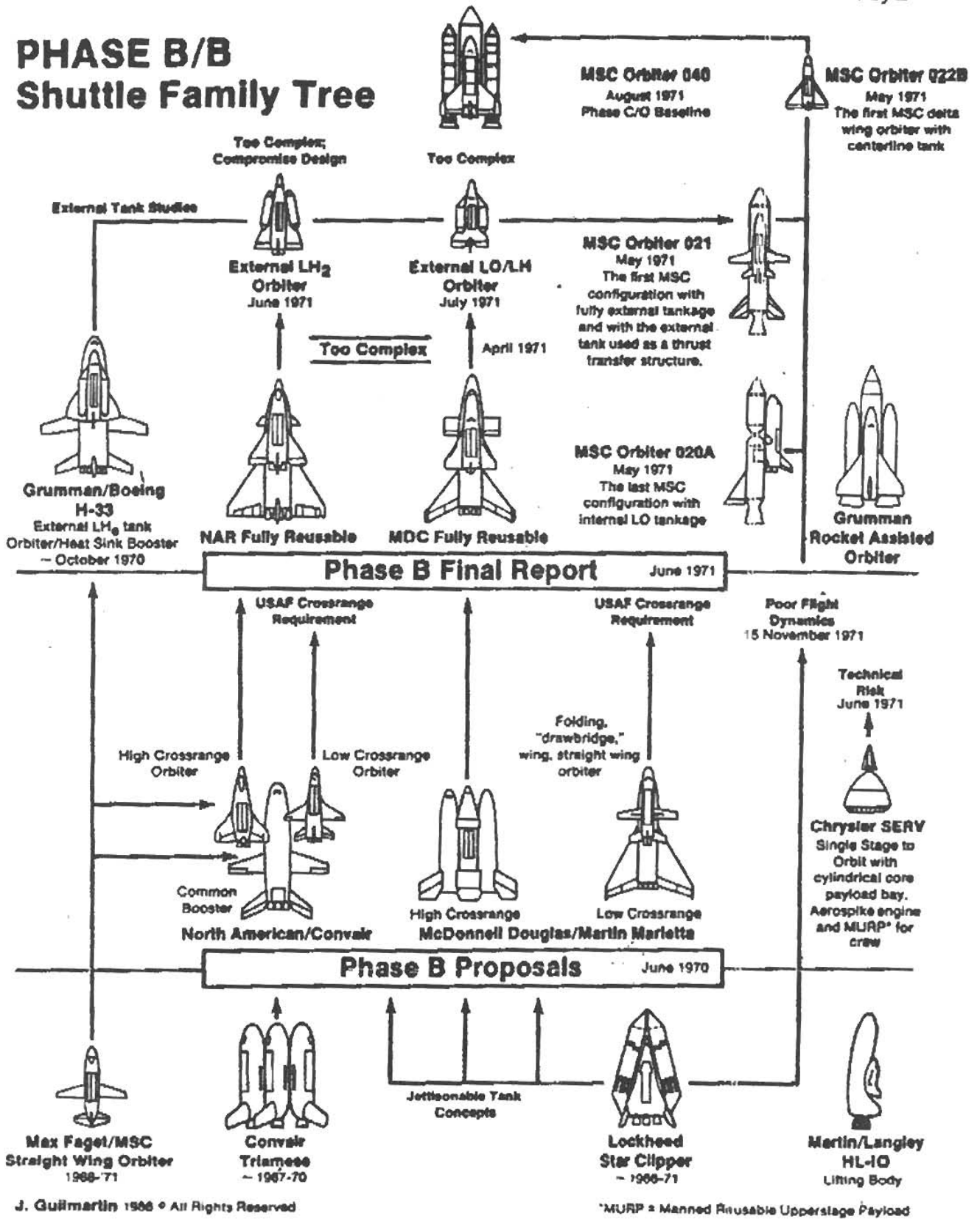
We place the highest importance on proceeding expeditiously with this program. Not only is it important to minimize the gap in U.S. manned space flights following Skylab in 1972-73, but economic analyses, which strongly support the development of the space shuttle on a cost-effective basis, show that a delay of a year in its availability development could increase the total cost of the U.S. space program by as much as \$2 billion.

4. Extend man's capability to live and work in space - The Skylab project, now in advanced stages of development, which requires substantial funding in FY 1972, is our only present flight program directed at this goal. Skylab will extend man's exposure to the space environment to 56 days, will perform an important manned solar astronomy experiment, and will extend our earth resources experiments beyond those carried out in the unmanned ERTS program. After its launch in late 1972 and three revisit missions through the first half of 1973, no further manned missions using Apollo hardware are planned. ~~We have made a major decision to defer development of a space station or "Skylab II" to a later time and to orient the space station studies we will continue in FY 1972 toward modular systems that can be launched as well as serviced by the space shuttle.~~

LIMITED ACCESS
DO NOT REPRODUCE

Figure 12

PHASE B/B Shuttle Family Tree



FACTORS FOR A DECISION ON
A NEW REUSABLE
SPACE TRANSPORTATION SYSTEM


Memorandum

for

Dr. James C. Fletcher, Administrator
National Aeronautics and Space Administration

by

Klaus P. Heiss
and
Oskar Morgenstern


October 28, 1971

- (1) A REUSABLE SPACE TRANSPORTATION SYSTEM IS ECONOMICALLY FEASIBLE, ASSUMING THAT THE LEVEL OF UNMANNED U.S. SPACE ACTIVITY WILL NOT BE LESS THAN IT HAS BEEN ON THE AVERAGE OVER THE LAST EIGHT YEARS.
- (2) AMONG THE MANY SPACE SHUTTLE CONFIGURATIONS SO FAR INVESTIGATED, AND WHICH ARE DEEMED TO BE TECHNOLOGICALLY FEASIBLE, A THRUST ASSISTED ORBITER SHUTTLE (TAOS) WITH EXTERNAL HYDROGEN/OXYGEN TANKS EMERGES AT PRESENT AS THE ECONOMICALLY PREFERRED CHOICE. EXAMPLES OF SUCH CONCEPTS ARE RATO OF MCDONNELL DOUGLAS AND TAHO OF GRUMMAN-BOEING.
- (3) THE DEMAND FOR SPACE TRANSPORTATION IN THE 1980's AND BEYOND BY THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, THE DEPARTMENT OF DEFENSE, BUT PARTICULARLY BY COMMERCIAL AND OTHER USERS IS THE BASIS FOR THE ECONOMIC JUSTIFICATION FOR THE TAOS PROGRAM. SUBSTANTIAL FURTHER EFFORT IN THIS AREA IS NEEDED TO DETERMINE THESE EXPECTED NEEDS.

The following sets forth briefly, in a summary manner, the principal considerations which lead to conclusions (1) and (2). The following arguments, which in their entirety support the recommendation (2), contribute significantly to alleviating the doubts voiced by the Congress, the public and several branches of the Executive concerning the need for a new Space Transportation System. Such doubts have been raised because of the magnitude of the investment involved and the comparative technological difficulty of the proposed undertaking.

TABLE 0.1: SPACE TRANSPORTATION SYSTEMS COST SUMMARY (1)

(Millions of Undiscounted 1970 Dollars)

Modified NASA and DoD Baseline
514 Space Shuttle Flights (1979-1990)

	Current Expendable	New Expendable	TAOS Space Shuttle and Tug
EXPECTED LAUNCH VEHICLE COSTS			
Non-Recurring Costs (FY1972-87)	1,620	2,000	7,450
Recurring Costs (FY1977-1990)	10,600	8,760	4,800
Total Launch Costs	12,000	11,000	12,000
EXPECTED PAYLOAD COSTS (SATELLITES)			
RDT&E (FY1975-1990)	11,000	10,600	9,880
Recurring Costs (FY1976-1990)	18,800	18,400	12,700
Total Payload Costs	30,000	29,000	23,000
EXPECTED TOTAL SPACE PROGRAM COSTS	42,000	40,000	35,000

(1) Source: Adapted from Aerospace Corporation and Contractor Data

Alexander H. Flux, President

1903

Dr. Edward E. David
Executive Office of the President
Office of Science and Technology
Washington, D. C. 20506

Dear Ed:

The Space Shuttle Panel has now had several meetings over a period of two months and I believe it would be useful to give you an interim report on our current impressions and opinions regarding the NASA Space Shuttle Program. Even during this brief period, as a result of ongoing technical and cost trade-off studies and program changes to accommodate changing FY-73 budget and peak year funding guidelines and constraints, the shuttle configuration and program phasing have been undergoing continuous revision. While, in my opinion, the searching examination and revision of the program which has been taking place has been, for the most part, healthy, it has limited the extent to which the Panel has been able to review in depth the merits of particular approaches and the plausibility of the economic and other justifications for the changing program plans.

Given the diversity of scientific and technical backgrounds, interests, and value systems represented among the Panel members, I am sure you will not be surprised to learn that up to this time, we are far from achieving any degree of unanimity regarding the attractiveness, utility, desirability, or necessity of the space shuttle system or, for that matter, on the virtues of alternatives to it. Nevertheless, there are some areas of fairly general agreement and some points of disagreement which I believe are worth reporting in order to help illuminate the critical issues.

Most of the members of the Panel doubt that a viable shuttle program can be undertaken without a degree of national commitment over a long term analogous to that which sustained the Apollo program. Such a degree of political and public support may be attainable, but it is certainly not now apparent.

FOR RESEARCH USE ONLY

NOT TO BE USED FOR DISTRIBUTION SALE

ALL INFORMATION CONTAINED HEREIN IS UNCLASSIFIED

DATE 10/10/01 BY 60322 UCBAW/STP

EXEMPT FROM AUTOMATIC DOWNGRADING AND DECLASSIFICATION

Dr. Edward E. David
October 19, 1971
Page 2

Planning a program as large and risky (with respect to both technology and cost) as the shuttle, with the long-term prospect of fixed ceiling budgets for the program and for NASA as a whole, does not bode well for the future of the program. Already some decisions regarding the shuttle system and program have been taken which introduce additional hazards to the success of the program technically, operationally, and economically in order to reduce projected peak-year funding requirements.

For this and other reasons, most Panel members feel that serious consideration must be given to less costly programs which, while they provide less advancement in space capability than the shuttle, still continue to maintain options for continuing manned spaceflight activity, enlarge space operational capabilities, and allow for further progress in space technology.

The attachment contains a more detailed discussion of questions considered by the Panel under the headings:

- I. Space Shuttle Objectives, Benefits and Viability
- II. Shuttle System and Program
- III. Shuttle Cost, Economics and Risks
- IV. Space Program Assessment
- V. Alternative Programs

Although I have tried in this letter and the attachment to reflect the consensus of the Panel, there has been no opportunity for the members to review and comment on them and they should therefore be considered to be in the nature of a Chairman's report on Panel activities.

Sincerely,



Alexander H. Flax

Attachment

FOR RESEARCH USE ONLY
DO NOT BE USED FOR REPRODUCTION, SALE
OR DISTRIBUTION WITHOUT WRITTEN
PERMISSION FROM THE NATIONAL ARCHIVES
SERIALS ACQUISITION

7) Acquisition of a low-orbit space rescue capability for space stations and other manned programs.

All of these benefits can be obtained in greater or less degree by developing systems other than the shuttle but it is difficult, if not impossible, to devise a single system other than the shuttle which would so adequately provide all of them. Further, by virtue of the fact that the shuttle is a system designed around man as an operator, it is difficult to conceive of a better way to achieve ready, safe, and easy access to space activity by man. Thus, the merit of the shuttle development is greatly enhanced if there is the expectation of a future space program in which frequent and extensive manned activity is an essential feature.

If an enthusiastic, optimistic, and expansionary view is taken of the probable growth of the nation's military and civilian space programs over the next twenty years and particularly if continuing growth in the manned program (e.g. space stations, lunar and planetary exploration, and the evolution of as yet undefined roles for man in space) is envisioned, the development of the space shuttle as proposed by NASA is undoubtedly the most important and valuable major new space program which could be undertaken at this time. However, both the investment and economic risk in the program are high and the payoffs may only materialize in the more distant future if space activities, and particularly manned activities, reach or exceed levels currently anticipated by most members of the Panel. A sustained sense of national commitment to the program and its objectives will be necessary to assure continuing support during the long period of high expenditures for development, facilities and production before any real payoff is obvious.

FOR RESEARCH USE ONLY
NOT TO BE USED FOR REPRODUCTION, SALE
OR PUBLICATION WITHOUT EXPRESS WRIT-
TEN PERMISSION (original in contractor polytechnic
institute archives.)

payloads cannot be achieved until the tug becomes available.

An option still being looked at for the shuttle program is the possible use of a parachute recovered pressure-fed booster in place of the fly-back recoverable booster. The use of a pressure-fed design leads to relatively thick tank walls which may be amenable to reentry loads, parachute retardation, and sea impact. The questions of reusability in light of refurbishment cost and number of reuses still remain to be explored in detail. If such a parachute-recoverable booster proves to be technically and economically feasible, it would be of considerable interest whether or not a shuttle program proceeded and would, in fact, make some of the alternatives to the shuttle program more attractive economically.

III. Shuttle Costs, Economics and Risks

The Panel has been impressed by the large amount of effort which has been put into cost analysis of the shuttle program and into the study of the economic cost-benefit justification for the program. Nevertheless, we are unconvinced that such analyses have sufficient credibility to serve as a primary basis for deciding to undertake such an expensive and high-risk program, although they are undoubtedly extremely valuable in making cost tradeoffs and in considering alternatives in design and program planning. We would also agree that the program objectives and plans should be analyzed in economic terms as one of the elements bearing on the decision to proceed with such a program.

FOIA
b1
b7C
b7D

PROTECTED
DATE
IN

On the other hand, we believe that a decision to proceed with a program such as the space shuttle should be based on an assessment of new capabilities it would provide and whether they serve the national purpose to a degree sufficient to justify the costs (necessarily uncertain). The contributions to such things as national prestige, international relations, and technological posture are by their nature largely intangible and unquantifiable, but they may be as important or more so than a 10 percent return on investment. Therefore, we do not wish to over-emphasize the purely economic justification of the shuttle. However, it is important to realize what the economic risks in a program of the magnitude of the space shuttle may be.

The complex computer-programmed cost model developed by Mathematica, Inc. under NASA contract to assimilate space and launch program data into a present value accounting system, while valuable for detailed comparisons, tends like all such models to focus attention away from essential assumptions and limitations of the model. In fact, there is ample evidence that it is difficult for space program offices and planners to clearly understand the nature of the input data required for the model. The Mathematica study dismisses cost risks by stating that "with an efficiently managed development program of the Space Shuttle and Tug System, the cost escalation experience of the early and middle 1960's should not apply to the present non-recurring cost estimates of the Space Shuttle System." The Panel cannot accept this point of view as valid. It is desirable, however, to consider the cost risks realistically with a much simpler model than that used by Mathematica, Inc. This simpler framework for cost

be undertaken, it must be primarily for the purpose of acquiring new capabilities, aggressively pursuing new opportunities in space, and assuring continuing national leadership in space technology and space activity. The relative economic advantages of the shuttle in an expanded space program are apparent in the second table above, since a larger number of launches and the higher cost of more advanced payload can provide savings of the same order of magnitude as the program cost risks associated with technical and operational uncertainties. The shuttle is particularly attractive if expanded and frequent manned spaceflight activities are foreseen, since in that case, costs of using expendable launch systems and Apollo type recovery will substantially increase the cost of using present technology over the figures considered above and will correspondingly increase the economic benefits of the space shuttle.

IV. Space Program Assessment

The general view of the Panel was that:

- 1) No significant role for manned spaceflight had been identified in space applications (military and civilian) or scientific experimentation. The NASA suggestion that the shuttle would allow scientific experimenters to conduct their activities as participants in spaceflight evoked no enthusiasm from the scientists. It must be noted here that new approaches such as the ones proposed by NASA have often not been recognized or appreciated by the putative users and beneficiaries until after they have been demonstrated, but the fact remains that at least, at present, the scientific community in the large doubts that the potential benefits of the space shuttle will be significant for science in relation to the large cost involved.

FOR RESEARCH USE ONLY
NOT TO BE USED FOR REPRODUCTION SALE
OR PUBLICATION
THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

- 2) An option for manned spaceflight activities should be retained into the future in view of the potential contributions of manned programs to national prestige, international cooperation, space exploration (although the Panel was divided as to the relative effectiveness of manned versus unmanned exploration), and the possibility of unforeseen future needs (military or civilian).
- 3) The space shuttle program cannot be justified on a purely economic basis for the unmanned part of the space program in view of the marginal benefits which can be shown and the high risk (based on past experience with major advanced technology programs) that both recurring costs and operational costs may be sufficiently in excess of present estimates to cause economic losses rather than savings over the 13-year period of operation from 1978-90.
- 4) The space shuttle program must be justified on the basis of: (a) the capability it will provide for new, different and more effective utilization of space for military and civilian purposes; (b) its contribution to retaining national leadership and prestige in space technology and advanced technology generally; (c) its unique value in providing easy, safe and flexible access to space by men at relatively low cost, if a program involving intensive and frequent manned spaceflight activity is to be undertaken.
- 5) In order to meet these criteria for justification of the space shuttle, it is necessary to postulate expanding rather than level space budgets for DOD and NASA over the next ten years. If the shuttle is to achieve the potentials which it may offer, it must generate (as many innovations have in the past) demands for space operations well beyond those now contemplated and funds would have to be made available to develop the necessary programs for utilization of the shuttle.
- 6) In order to insure sustained public support for the space shuttle over the long period of high expenditures before the first flight in the face of possible cost escalation and technical difficulties, it will be necessary to obtain a

FOR RESEARCH USE ONLY

NOT TO BE USED FOR REPRODUCTION, SALE
OR PUBLICATION WITHOUT THE WRIT-
TEN PERMISSION OF THE NATIONAL AERONAUTICS
AND SPACE ADMINISTRATION

INSURANCE

000000

degree of national commitment to the program and its objectives similar to that which attended the Apollo program. It seems unlikely that the aim of reducing space program costs and achieving a return on the investment ten to twenty years hence could be more than a minor factor in sustaining such a commitment.

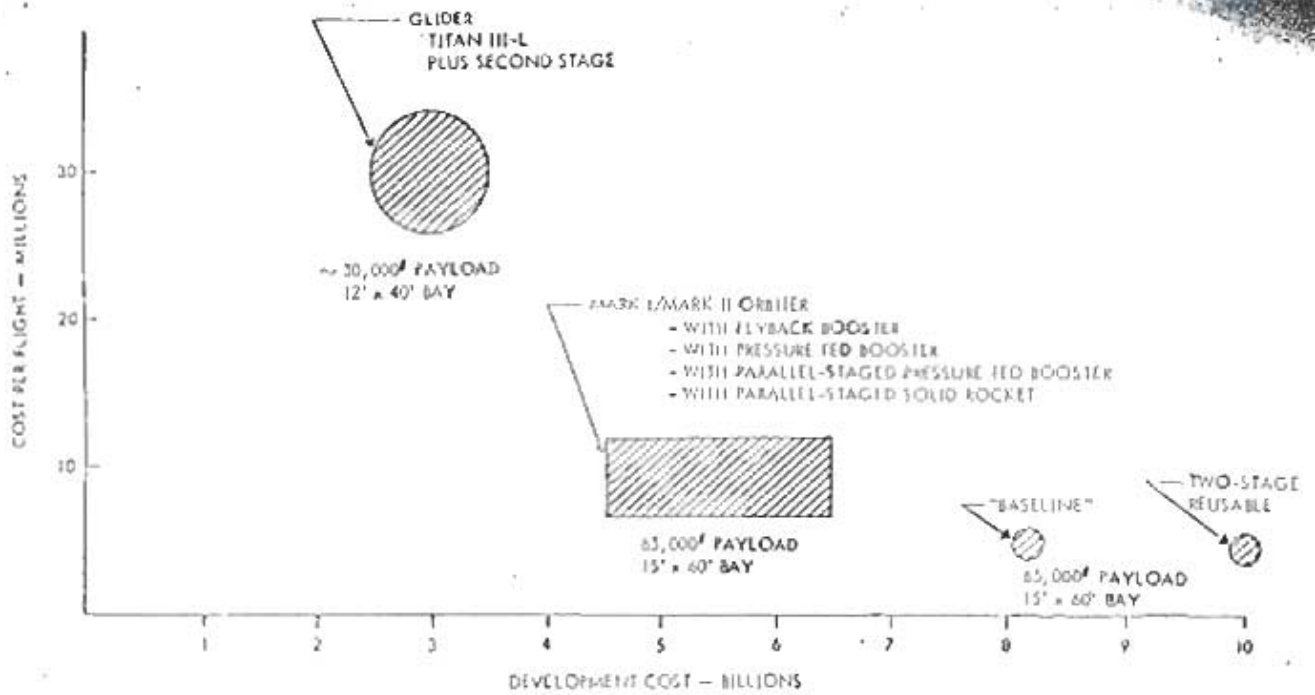
V. Alternative Programs

The Panel considered a number of alternatives to development of the shuttle which would provide lesser capabilities and lesser potential long-range future cost savings than the shuttle program but which met to some degree the requirements for a continuing manned program and for further progress in space and space vehicle technology. Unfortunately, the costs and technical data for such programs have not been available in anywhere near the depth and detail as for the shuttle program; this is not at all surprising in view of the massive funding and emphasis which the shuttle program has received over the past two years.

Objections can be and were raised to every alternative program on the grounds that, although it was cheaper than the shuttle program, the potential benefits were so much smaller that the cost of such programs could not be justified. Such objections effectively left only two alternatives for the next ten years: either (1) proceed with the shuttle program now or soon, or (2) drop manned spaceflight activity after Skylab A and the possible Salyut visit and do nothing new in space vehicle and space operations technology. Most of the Panel rejected these "all or nothing" views.

FOR RESEARCH USE ONLY
NOT TO BE USED FOR PRODUCTION SALE
OR FOR OTHER COMMERCIAL PURPOSES
TECHNICAL STAFF
NSAS/DO (30/10/62)

SPACE SHUTTLE COST COMPARISON



REV 1171

Space Shuttle
11/22/71

NOV 22 1971

MEMORANDUM FOR: Mr. Jonathan Rose
Special Assistant to the President
The White House

As you requested, I am sending you a paper on the space shuttle. In this paper we stress the following points:

1. The U.S. cannot forego manned space flight.
2. The space shuttle is the only meaningful new manned space program that can be accomplished on a modest budget.
3. The space shuttle is a necessary next step for the practical use of space. It will help
 - space science,
 - civilian space applications,
 - military space applications, and
 - the U.S. position in international competition and cooperation in space.
4. The cost and complexity of today's shuttle is one-half of what it was six months ago.
5. Starting the shuttle now will have a significant positive effect on aerospace employment. Not starting would be a serious blow to both the morale and health of the Aerospace Industry.

Please let me know if I can provide any additional information.

James C. Fletcher
Administrator

GML/WHS:aom 11-22-71

Enclosure

Taft

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

MEMORANDUM FOR PETER FLANIGAN

Subject: Space Shuttle Program

Attached are the two papers on the impact of the space shuttle on the aerospace industry which you requested.

You should be aware that these employment estimates are preliminary. As the paper indicates no decision on development has been made. The critical contractor selections will not be made until the Administration has approved the project. NASA expects approval in August, but it may be delayed until late 1971 when the 1973 Budget is decided. If the decision is delayed the employment impacts will also be delayed by approximately 6 months.

Arnold R. Weber
Associate Director

Attachments

NASA's Space Shuttle Program

The space shuttle would be a reusable space transportation system, consisting of an orbiter and a booster, which would carry NASA and DOD payloads to and from earth orbit beginning in 1979. The shuttle would replace all but the very smallest and very largest (Saturn V) expendable rockets. The investment costs (research and development, facilities, and initial fleet) of the shuttle would be about \$14 billion through FY 1979 when the shuttle would, under NASA's schedule, become operational.

Thus far, the Administration has not approved NASA's plan for the fully reusable shuttle. The 1972 budget provides \$100 million for initial development of the engine (the longest lead-time item) and continuing design of the shuttle airframe. However, the initiation of development of the airframe is contingent upon favorable assessment of technical and economic studies and a positive decision by the Administration that NASA can proceed with fullscale development. NASA is now completing the various studies required including an economic analysis.

1. Engines

NASA intends to announce a contractor selection on the engine near the end of June. This is a firm date based on presently budgeted funds. There are three contractors currently competing for the engine contract:

- a. Aerojet General ... Sacramento, California
- b. Rocketdyne (North American Rockwell) ... Canoga Park, California
- c. Pratt and Whitney ... West Palm Beach, Florida

Anticipated Employment:

<u>6/71</u>	<u>12/71</u>	<u>6/72</u>	<u>12/72</u>
500	1500	2500	3500

2. Airframe

NASA's current schedule calls for an Administration decision on the shuttle airframe in August, followed by issuance of a Request for Proposals (RFP) in early September, and contractor selection in December. However, in order to look at alternative phasing plans, NASA is

seriously considering stretching out this schedule by several months. There are currently two contractor teams competing for the major shuttle contract (airframe):

1. McDonnell Douglas ... Los Angeles, California and St. Louis, Mo.
2. North American Rockwell ... Los Angeles, California

If NASA received the go-ahead decision on the airframe in September, the following contractor employment pattern would be likely:

Anticipated Employment:

<u>Decision Time</u>	<u>6/71</u>	<u>12/71</u>	<u>6/72</u>	<u>12/72</u>
August 1971	500	1500	4000	7000
January 1971	500	500	1500	4000


Thus, although a peak of 70,000 jobs might ultimately result from the shuttle in the mid-1970's, the number of actual jobs by the end of CY 1972 would be relatively small.

3. Launch Site

A NASA evaluation group is reviewing alternative launch sites including Cape Kennedy, Fla; Edwards Air Force Base, California; White Sands, N. M.; and Wendover Air Force Base, Utah. From a cost standpoint, Cape Kennedy has the advantage (investment cost of \$3-400 million vs. \$800 million-\$1 billion required elsewhere). A recommendation is expected in September.

There would be no employment impact at the launch site during 1972. Employment would peak at about 6,000 in 1980.

Alternatives to NASA's current plan which would decrease near-term costs and employment include a phased development of the shuttle (orbiter first), a partially reusable shuttle with expendable drop tanks, and improved fully expendable rockets. The FY 1973 budget will be a key decision point for the shuttle alternatives.



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICE OF THE ADMINISTRATOR

December 29, 1971

Honorable Caspar W. Weinberger
Deputy Director
Office of Management and Budget
Executive Office of the President
Washington, D.C. 20503

Dear Cap:

The purpose of this letter is to report the results of recent studies of several space shuttle options, and to recommend a course of action to be taken in the FY 1973 budget.

SUMMARY

We have concluded that the full capability 15 x 60' - 65,000# payload shuttle still represents a "best buy", and in ordinary times should be developed. However, in recognition of the extremely severe near-term budgetary problems, we are recommending a somewhat smaller vehicle-- one with a 14 x 45' - 45,000# payload capability, at a somewhat reduced overall cost.

This is the smallest vehicle that we can still consider to be useful for manned flight as well as a variety of unmanned payloads. However, it will not accommodate many DOD payloads and some planetary payloads.

Also, it will not accommodate a space tug together with a payload, and will therefore not provide an effective capability to return payloads or propulsive stages from high "synchronous" orbits, where most applications payloads are placed.

BACKGROUND

Early in 1971, after completion of feasibility studies, NASA focused on a shuttle configuration that would replace all of the existing launch vehicles (except the very small Scout, and the very large Saturn V); would provide for a continuation of manned space flight; and would have the lowest possible cost per flight. This configuration had a 15 x 60' -65,000# payload bay; a very large orbiter; and a huge fly-back booster. It would cost \$10 billion to develop, and \$4.1 million per flight.

We then set out to optimize the configuration for the best balance between development cost and operating cost, while retaining the full 15 x 60' - 65,000# capability

RESULTS OF STUDIES

<u>CASE</u>	1	2	2A	3	4
PAYLOAD BAY (FT.)	10 x 30	12 x 40	14 x 45	14 x 50	15 x 60
PAYLOAD WEIGHT (LBS.)	30,000	30,000	45,000	65,000	65,000
DEVELOPMENT COST (BILLIONS)	4.7	4.9	5.0	5.2	5.5
OPERATING COST (\$BILLIONS/FLT.)	6.6	7.0	7.5	7.6	7.7
PAYLOAD COSTS (\$/POUND)	220	223	167	115	118

Letter from James Fletcher to
LARRY WEINBERGER, DEC 29, 1971

001-1221

OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

August 12, 1971

MEMORANDUM FOR THE PRESIDENT

From: Caspar W. Weinberger

Via: George P. Shultz

Subject: Future of NASA

*I agree with
Cap*

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

I believe this would be a mistake.

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

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

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

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

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

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

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

6) I do not propose that we necessarily fund all NASA seeks -- only that if we decide to eliminate Apollo 16 and 17, that we couple any announcement to that effect with announcements that we are going to fund space shuttles, NERVA, or other major, future NASA activities. We could perhaps base any announcement of curtailment of Apollo 16 and 17 on the ground that Apollo 15 was so successful in gathering needed data that we can now shift, sooner than previously expected, to the Space Shuttle, Grand Tour, NERVA, etc. Also, I am certainly

Logs done

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546



OFFICE OF THE ADMINISTRATOR

January 12, 1972

SENSITIVE

MEMORANDUM FOR THE RECORD

SUBJECT: Meeting with the President on January 5, 1972

Jim Fletcher and I met with the President and John Ehrlichman for approximately 40 minutes to discuss the space shuttle. During the course of the discussion, the President either made or agreed with the following points:

1. The Space Shuttle. The President stated that we should stress civilian applications but not to the exclusion of military applications. We should not hesitate to mention the military applications as well. He was interested in the possibility of routine operations and quick reaction times, particularly as these would apply to problems of natural disasters, such as earthquakes or floods. When Dr. Fletcher mentioned a future possibility of collecting solar power in orbit and beaming it down to earth, the President indicated that these kinds of things tend to happen much more quickly than we now expect and that we should not hesitate to talk about them now. He was also interested in the nuclear waste disposal possibilities. The President liked the fact that ordinary people would be able to fly in the shuttle, and that the only requirement for a flight would be that there is a mission to be performed. He also reiterated his concern for preserving the skills of the people in the aerospace industry.

In summary, the President said that even though we now know of many things that the shuttle will be able to do, we should realize that it will open up entirely new fields when we actually have the capability that the shuttle will provide. The President wanted to know if we

thought the shuttle was a good investment and, upon receiving our affirmative reply, requested that we stress the fact that the shuttle is not a "\$7 billion toy," that it is indeed useful, and that it is a good investment in that it will cut operations costs by a factor of 10. But he indicated that even if it were not a good investment, we would have to do it anyway, because space flight is here to stay. Men are flying in space now and will continue to fly in space, and we'd best be part of it.

2. International Cooperation. The President said that he is most interested in making the space program a truly international program and that he had previously expressed that interest. He wanted us to stress international cooperation and participation for all nations. He said that he was disappointed that we had been unable to fly foreign astronauts on Apollo, but understood the reasons for our inability to do so. He understood that foreign astronauts of all nations could fly in the shuttle and appeared to be particularly interested in Eastern European participation in the flight program. However, in connection with international cooperation, he is not only interested in flying foreign astronauts, but also in other types of meaningful participation, both in experiments and even in space hardware development.

3. USSR Cooperation. The President was interested in our joint activities with the USSR in connection with the probes now in orbit around Mars. We also described to him the real possibility of conducting a joint docking experiment in the 1975 time period. The prospect of having Americans and Russians meet in space in this time period appeared to have great appeal to the President. He indicated that this should be considered as a possible item for early policy level discussions with the USSR.

The President asked John Ehrlichman to mention both the international aspects of the shuttle and the USSR docking possibilities to Henry Kissinger.

George M. Low
George M. Low

cc: A/Dr. Fletcher



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICE OF THE ADMINISTRATOR

MAR 9 1972

Honorable Caspar W. Weinberger
Deputy Director
Office of Management and Budget
Executive Office of the President
Washington, D.C. 20503

Dear Cap:

With regard to the space shuttle, we decided in George Shultz's office on January 3 that we would develop a shuttle with a 15x60 - 65,000# payload capability. At that time I urged that we look further at what kind of a booster to use -- liquid or solid -- and decide that issue in the spring. In addition, I proposed at that time that we would continue to look at a somewhat smaller size shuttle (14x45' - 45,000# payload) for the sole purpose of determining whether or not, if we choose the solid booster, substantial cost savings could be obtained from the use of the smaller vehicle.

Our studies have now been completed, and we have reached the following conclusions:

1. The use of solid boosters in the parallel staged configuration represents the optimum choice from combined technical and budgetary points of view.
2. Our prior decision to incorporate the larger payload capability is confirmed by our subsequent analysis from an overall program point of view, notwithstanding our choice of the solid rocket booster.

We plan to announce these conclusions shortly before or at a hearing before the Manned Space Flight Subcommittee of the House Committee on Science and Astronautics, scheduled for March 16, 1972. Issuance of the RFP will come as soon as

possible thereafter. As I told you earlier, the Committee has demanded a firm decision by the time of our appearance regarding shuttle configuration and choice of booster. In order to assure timely passage of the President's shuttle program by the Congress, our legislative experts believe it essential that the Committee's firm deadline be met. Since we met last Friday, a scheduling problem with our Senate Authorization Committee has also developed. This may require an announcement of the decision on March 15, one day earlier.

The decision concerning liquid or solid boosters was a difficult one. It involves a trade-off between future benefits (at the time the shuttle becomes operational) and earlier savings in the immediate years ahead: liquid boosters have lower potential operating costs, while solid boosters have lower development costs. The decision concerns development risk which is lower for the solids because the technical unknowns are less, and also risks in operational costs which favor the solids because the economic exposure of failing to recover a booster is much less.

Another approach in reaching this decision involved adding all costs together -- development, investment and operating. However, the conclusions here are heavily dependent on the mission model, with the liquid booster favored if we assume a large number of flights per year, and the solids if the number of flights per year is less.

Based on the results of our contractor studies and our in-house estimates, and with our great concern about holding down development costs in these years of tight fiscal constraint, our decision must be in favor of the solid booster. We feel quite confident of being able to develop the solid-boosted shuttle for less than the \$5.5 billion committed to you last January and, hopefully, when we have developed the data more firmly we may be able to commit to a smaller overrun amount than the 20 percent mentioned in my January 23 letter.

From the budgetary point of view, perhaps the most important consideration is that we have selected the configuration which, for a given payload size and weight, entails the lowest development cost. Thus there would seem to be no budgetary interest in further delay.

Our reaffirmation of the payload size is based on the facts that the differences in development and operational costs between the larger and smaller versions have been verified to be very small; that these savings would nowhere near compensate for the future savings that would be lost because of the many important payloads which cannot be accommodated in the smaller shuttle; and that the President's expressed desire to make the shuttle a useful vehicle for military space operations could not be fulfilled with the smaller shuttle.

George Shultz' letter of February 16 transmitted a number of detailed questions on matters relating to the booster decision and payload size reaffirmation. We intend to provide answers to as many of these as possible before March 15 but, because of the short timetable under which recent studies have been made, the bulk of the material needed for proper response will not be finalized for submission to your office until March 13. George Low has arranged to meet with Don Rice on March 7 to present and discuss the material then available and to identify on a timely basis any matters of special concern.

We will present our plans, along with supporting data, to members of your staff, to other members of the White House staff who have been involved with the shuttle, and to a committee of outside experts which will convene after March 10 to review in depth our conclusions and considerations which support them.

During our meeting of March 3, 1972, we also discussed another matter: that of an expenditure ceiling of \$3.2 billion of outlays during the time of shuttle development stated as a "previous understanding" in George Shultz' letter of

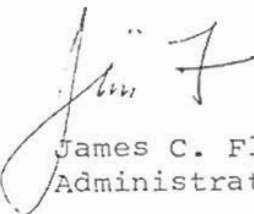
February 16. I told you that this had not been my understanding; instead I had planned on our new obligational authority to remain essentially constant at the FY 1973 level -- \$3,379 billion -- over the next several years. You and I did not settle this matter, but you agreed that the issue is separate from the shuttle decision and should be considered later in the context of the FY 1974 budget, and not now.

In summary:

1. We plan to develop a shuttle making use of solid boosters in the parallel-staged configuration. From the budgetary point of view, this is the lowest development cost option.
2. Our analysis has reaffirmed the previous conclusion reached in January that the shuttle should have a 15x60, 65,000# payload capability.
3. We need to iron out our differences concerning NASA's constant budget -- whether this is based on FY 1973 outlays or NOA. However, you have agreed that this is not an issue involved in this immediate decision -- it will be discussed in terms of the FY 1974 budget preparations at a later date.

We look forward to working with you in the future as we have in the past toward the success of this most important program.

Sincerely,



James C. Fletcher
Administrator

cc: Honorable George P. Shultz
Honorable Edward E. David, Jr.
Honorable Peter M. Flanigan
Mr. Donald B. Rice