

**SPACE STATION
HISTORY PROJECT**

SPACE STATION TASK FORCE

Dr. James C. Fletcher
Chairman
Burroughs Corporation

Dr. George E. Mueller
Systems Development Corporation

Mr. Leslie C. Dirks
Central Intelligence Agency

Dr. Robert R. Gilruth
Former JSC Center Director

Mr. Willis H. Shapley
Former NASA Assoc. Dep. Administrator

Dr. James Arnold
University of California-San Diego

Mr. Frank W. Lehan
Aerospace Consultant

Dr. Thomas O. Paine
Northrop Corporation

Mr. William A. Anders
General Electric Company

Mr. Thomas C. Reed
Quaker Hill Development Corporation

General Pete Crow
Former NASA Assoc. Dep. Administrator

FINAL REPORT
STUDY GROUP ON SPACE STATION

To conclude the work of the study group conducted by the University of Pittsburgh (see Attachment 1 for membership) this final summary of our work is submitted. The study group was specifically tasked to:

Identify the key functions of a manned space station, establishing a set of priorities among them.

Specify and comment upon the various programmatic approaches to developing a manned space station.

Review the range of costs associated with the development of a manned space station.

Identify and assess the technological advances necessary for such a station.

Examine the decision-making processes by which a national commitment to a manned space station is confirmed.

Review current NASA plans and planning processes regarding a manned space station.

The study group did indeed address each of these items and provided inputs and guidance to a number of studies conducted by NASA and associated contractors. The work of the committee consisted for the most part in providing this guidance but in the process fulfilled each of the tasks outlined above. The format of this report will not follow the outlined tasks but rather will start with principal conclusions and observations, followed by some arguments which support these conclusions. The review of (1) costs for the various options, (2) the decision-making processes, and (3) the planning processes has been made and transmitted verbally to the Administrator and Deputy Administrator but will be referred to in this report only coincidentally as they bear on the principal conclusions.

The study group met six times as a group but members visited all of the contractors involved in Space Station studies and made visits to OSTP, various intelligence organizations and to the Department of Defense (DoD). In addition, as a group, we were briefed by representatives of NASA Headquarters, Marshall

Space Flight Center, Johnson Space Flight Center, the United States Air Force, and the CIA. Numerous versions of a space station were studied and discussed but the various versions seemed to cluster around the following options:

- Option (1) An unmanned platform, permanently maintained, for a variety of space science and applications missions.

- Option (2) A minimum manned platform which would allow 2 - 3 men to remain permanently in space but would be maintained and refurbished from the Space Shuttle. This minimum platform would have some utility for space science and applications, as well as Defense and intelligence missions but would only make sense if it could evolve into a platform with broader capabilities for use by scientists, industry and the Department of Defense. The possibility of cannibalizing one or more Space Labs to provide such a platform for minimum cost was considered.

- Option (3) An intermediate manned platform which would have designed into it the ability to grow in size, power and capability. Several ways were considered which would allow this intermediate platform to grow into a full-sized Space Station.

- Option (4) A full-sized Space Station which would include, but not be limited to:
 - o Servicing of satellites and payloads
 - o Attached payloads
 - o Co-orbiting satellites
 - o Higher energy orbit satellites

 - o Flight support of spacecraft
 - o Unmanned orbit transfer vehicles
 - o Manned orbit transfer vehicles
 - o Shuttle

 - o Space construction
 - o Assemble and check out large systems
 - o Transfer to operational orbit

 - o Earth and near earth observation

 - o Space and life sciences

 - o Long duration experiments and processing

 - o Research and development

The costs of each of these would cover a range of one to ten billion dollars from the unmanned to the full-sized space station. The principal conclusions of the group were:

1. NASA ought to start as soon as practically possible, the development of a manned system (i.e., option (1) did not make sense as a first step). The primary reason for urgency is the recent Soviet "activity" in space. A secondary reason is that development of the Space Shuttle is rapidly coming to completion and the space station is the next logical step toward a more permanent presence in space.
2. If it were possible to start the program in the next year or so, the preferred options would be either the minimum manned (option 2) or the Intermediate manned (option 3) because of the current severe restrictions on the Federal budget. If either option 2 or option 3 were begun, the capability to evolve into the full-sized station must be maintained. Starting with option 2 would be most difficult to evolve into a station but at worst it could be the basis for a more optimally designed space station based on early experience with long duration occupation of the habitat and the performance of long duration experiments. At best the system could be minimally "scarred" to allow new modules to be attached gradually building to a full-sized station.
3. The station can ultimately be built using modules which fit into the present Space Shuttle payload bay.
4. Whichever option were chosen as the basis for the first step, it is imperative to involve the Department of Defense from the very beginning. The Soviet threat is clearly the most compelling reason for starting as soon as possible, hence, DoD involvement is the only way to optimally counter this threat.
5. The Shuttle External Tanks (as studied by a subpanel of the study group) should be a useful adjunct to the first step. It may be possible to start a "mini-platform" using discarded External Tanks even before option 2 or 3 with no cost in Shuttle payload weight or flexibility.

A brief outline of why a Space Station development should start now was prepared for the Administrator and can be found in attachment 2. Briefing the Space Station would:

- (1) Prevent the U.S. from falling even further behind the very active U.S.S.R manned Space Station program.
- (2) Extend U.S. capabilities in space by providing a permanent base for man-tended military and civilian use for:
 - a. Observation and surveillance of the earth;
 - b. Scientific research;

- c. Experiments for construction or assembly of large structures (e.g., antennas);
 - d. Further demonstration of space manufacturing and processing, especially when long dwell times are required;
 - e. Experimental payload testing.
- (3) Provide a sortie base for intercept and inspection of other satellites.
- (4) Stimulate new technology.

Although options 2 and 3 would provide only a partial capability, the full-sized space station would:

- o Optimize operational capabilities of Shuttle and reduce the number of additional orbiters required in the 1990's by providing:
 - o Capability for long duration missions
 - o A base for emergency servicing of Shuttle in space
 - o A base for servicing reusable OTV's
- o Provide one or two bases for man-tended selective observation and surveillance of the earth (military and civil)
- o Provide a capability for command, control and communications
- o Provide a sortie base for intercept and inspection of other satellites
- o Provide a base for construction or assembly of large structures in space (antennas, solar powered OTV's)
- o Provide a base for full exploitation of space manufacturing or processing possibilities
- o Provide a base for space science activities that can use to advantage a permanent man-tended facility
- o Serve as a prototype of a long duration manned vehicle for future manned operations at geo or beyond
- o Open up a range of new capabilities that are not yet fully understood for both the civilian and defense communities
- o Serve as a motivation for international cooperation perhaps with NATO for the military functions.

The study group found that no contractor or NASA Center was looking seriously at the possibility of using expended External Tanks as a possible platform. A sub-panel was set up under Professor James Arnold to explore this possibility. Surprisingly enough a number of inexpensive possibilities exist for using External Tanks either singly or strapped together:

1. Using a double tether attached to the two ends of the tank from which hangs a weight (approximately 1000 Kg), the tank becomes stabilized vertically through gravity-gradient and horizontally through the double tether (pitch) and drag (yaw). This then represents a stabilized platform with a very large moment of inertia with very little further stabilization required for most experiments.
2. There remains a minimum of 10,000 pounds of fuel ($H_2 + O_2$) on each flight which can be used to (a) fuel a drag make-up motor (approximately 1000 pounds per year) (b) fuel cells on a possible manned space station or an attached experiment module (c) provide life support (O_2) if used as a "life raft."
3. The tank itself is very large (28 feet in diameter and over 200 feet long) but in addition, has attached to it, the "Aft Cargo Bay." The latter could be used as a laboratory comparable in size to Skylab.

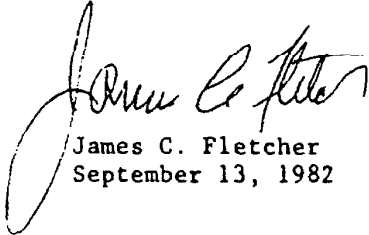
Early uses of these tanks could be:

- (1) As a proof of concept using a simple tether and one tank.
- (2) As a "life boat" in case, for some reason, an orbiter was temporarily stranded in space or as a substitute life boat in connection with a manned space station.
- (3) As an enhanced cargo bay.
- (4) For simple science experiments (occultation, etc.).
- (5) For long duration experiments (biology, cosmic rays, solar wind fluctuations, etc.).
- (6) Military applications (experimental or possibly operational).

Later the External Tanks could be strapped together (say in groups of 3-4) as two flat platforms tied together with a tether. Such a platform would also be gravity-gradient stabilized and even manned (with gravity-gradient tending to keep the man upright). Many variations of this concept were studied by the sub-panel, all interesting and encouraging enough for the study group to recommend incorporating in the early planning for the Space Station.

The study group concluded its work by suggesting further study on:

- (1) Military applications for the External Tanks.
- (2) In-depth studies of the possible use of a manned platform for military and intelligence purposes (at the time of this writing, a start on this had been made by creating an ad hoc space-platform task force within the U. S. Air Force).
- (3) Further exploration of the possibility of including Europe, Canada and Japan in NASA's Space Station planning activities.
- (4) Further study of the design of improved "minimum space platform" option which could facilitate growth to a full space station (e.g. possible use of fuel cells re-fueled by residual fuel in External Tanks as a replacement for solar panels).



James C. Fletcher
September 13, 1982

November 6, 1981

ATTACHMENT A

**SPACE STATION
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SCOPE/STATEMENT OF WORK

1. Background. For many years NASA has given serious thought to a permanent, manned space station in low earth orbit. Such a station would provide a unique vantage point from which to conduct operations in space for purposes of science, applications and national security. The three Skylab missions in the early 1970's demonstrated the feasibility of man working in such an orbiting facility over a long period of time. With the advent of the Space Shuttle which will provide routine access to low earth orbit (upon which a manned space station would depend) a permanent orbiting facility has become a realistic program upon which the United States could embark. The Soviet Union already is committed to a manned space station, having launched the Salyut 6 spacecraft in 1977.
2. Scope/Statement of Work. The University of Pittsburgh shall furnish the necessary technical, support and administrative personnel and services to examine the specific functions, required technologies, potential costs and decision-making processes associated with various concepts for the development of a permanent manned space station. Specifically, Dr. James C. Fletcher shall chair a study group which shall:
 - 2.1 Identify the key functions of a manned space station, establishing a set of priorities among them.
 - 2.2 Specify and comment upon the various programmatic approaches to developing a manned space station.
 - 2.3 Review the range of costs associated with the development of a manned space station.
 - 2.4 Identify and assess the technological advances necessary for such a station.
 - 2.5 Examine the decision-making processes by which a national commitment to a manned space station is confirmed.
 - 2.6 Review current NASA plans and planning processes regarding a manned space station.
3. Deliverables. Dr. James C. Fletcher shall provide:

- 3.1 An interim verbal report to the NASA Administrator and Deputy Administrator, no later than February 15, 1982.
- 3.2 A one-hour verbal final report to the NASA Administrator and Deputy Administrator, no later than July 12, 1982.
- 3.3 A written final report, between four and fifteen pages in length that summarizes the findings and recommendations of the group, no later than July 12, 1982.

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JUSTIFICATION FOR NONCOMPETITIVE PROCUREMENT

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I recommend the National Aeronautics and Space Administration (NASA) negotiate with the University of Pittsburgh only to provide the study discussed below.

Dr. Hans Mark, Deputy Administrator of NASA, has asked Dr. James C. Fletcher of the University of Pittsburgh to examine the specific functions, required technologies, potential costs and decision-making processes associated with the various concepts for the development of a permanent, manned space station.

Specifically, Dr. Fletcher will chair a study group to:

- o identify the key functions of a manned space station, establishing a set of priorities among them
- o specify and comment upon the various programmatic approaches to developing a manned space station
- o review the range of costs associated with the development of a manned space station
- o identify and assess the technological advances necessary for such a station
- o examine the decision-making processes by which a national commitment to a manned space station is confirmed
- o review current NASA plans and planning processes regarding a manned space station

Dr. Fletcher will present an interim report (verbal) and a final report (verbal and written) summarizing the findings and recommendations of the group.

Dr. Fletcher was selected to chair this group because of his:

- o unique experience, as a former NASA Administrator, in translating ideas for broadly based national programs into sound, realistic and conceptually clear projects that can be undertaken in a time of fiscal restraint
- o background at the highest levels of government in the management of complex research and development programs
- o ability to reach easily and communicate with the nation's most senior and talented people in academia,

business, and government

- o understanding, based upon previous participation, of the decision-making processes necessary for a national commitment to a manned space station and other major "New Starts"
- o knowledge, based upon personal experience, of the total NASA institution, its strengths and weaknesses, its unique characteristics and peculiarities that will allow sound assessments of the technological and managerial concepts to be discussed by NASA and its potential contractors

Dr. Fletcher is considered the only qualified individual for the job based upon the above combination of experiences and capabilities.



Philip E. Culbertson
Assistant for Space Transportation Systems
Office of the Administrator

11/13/81
Date

Concur: _____
J. Ronald Jeshow
Assistant Procurement Officer

Date

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Some Q and A's

o interest in; Dr. Fletcher's study may be expressed by

- the trade press
- Congress
- OMB'ers
- White House staff
- Keyworth & Co.
- ESA
- Air Force and others
- buffs and nuts

Question: Why, in a time of fiscal duress, when money for new starts has dried up and when the Shuttle is far from complete, is NASA spending scarce dollars on a manned space station?

Answer: Any agency or business, but particularly a R and D institution such as NASA, must continuously plan for the future. The advent of the Shuttle with its promise of routine access to low-earth orbit and the development of space technologies in general make a space station appear to be the next logical step in the exploration and utilization of space. Money, however, will be spent not on a manned space station but on studying the concepts underlying such a station.

Question: Obviously this country, under current economic conditions, is not going to embark upon a multi-billion dollar project for purposes of space science. The only possible justification for a space station at this time is military. So NASA is fronting for the Pentagon which, in any case, should be picking up the tab.

Answer: The question prejudices the study to be conducted by Dr. Fletcher. In fact, just what functions a manned space station could usefully perform needs to be examined and more clearly defined, as do the specific technologies that might be required. A space station could serve both the military and civilian sectors of our society but how well it might serve and when, and at what cost is as yet undetermined. The study by Dr. Fletcher will assist NASA and others, including the Air Force, to have a clearer understanding of what a manned space station might usefully do. NASA is paying for the study because NASA is interested in sharpening its thinking about space stations and has asked Dr. Fletcher, a former NASA Administrator, to undertake the study.

Question: Why did NASA sole source this contract to Jim Fletcher? Shouldn't others have been allowed to compete for the contract?

Answer: Dr. Fletcher's unique experience, as a former NASA Administrator, enables him to translate ideas for broadly-based national programs--such as a space station--into sound realistic and conceptually clear projects that can be undertaken in a time of fiscal restraint. This ability, plus his knowledge of NASA and his background at the highest levels of government in the management of complex research and development programs make him the ideal choice for the study NASA requires.

Question: Why didn't NASA employ its in-place advisory council structure if advice on a space station were needed?

Answer: Because the Advisory Council has recently embarked upon a major goals study (to be headed by Dr. John Naugle, former Chief Scientist at NASA) and additional work at this time would be burdensome. At a later date, it may well be timely for the Council to focus upon a space station. In addition, the Advisory Council's membership does not--in this instance--match the unique suitability for the study offered by Dr. Fletcher and his experience.

Question: What is the relationship of the Naugle study on NASA goals and the Fletcher study on a manned space station?

Answer: Dr. Naugle is leading a NASA Advisory Council study of the advisability, feasibility and implications of setting as a goal for NASA the capability to enable future generations to establish self-sustaining human habitations in space should they decide to do so. Dr. Fletcher's study is very different. It is dealing with the near term option of developing a manned space station in the 1980's or 1990's. This station would not be self-sustaining and, in practice, would involve far fewer people in space than envisioned by the approach to be looked at by Dr. Naugle. Moreover, this approach is contemplating the setting of a goal while Dr. Fletcher's effort is further defining a near-term potential project.

Question: Ought the effort by Dr. Fletcher await the outcome of the space policy review being conducted by Dr. Keyworth, the President's Science Advisor? It makes little sense for Dr. Fletcher, or for that matter NASA, to proceed with examining a manned space station if the Keyworth effort concludes that such a station is not warranted.

Answer: NASA is aware of and contributing to Dr. Keyworth's policy review. However, the utility of further defining the specific functions of a manned space station and of sharpening NASA's thinking about such a station exists independently of Dr. Keyworth's effort. It may be that Dr. Fletcher's study may help NASA to understand the ramifications of Dr. Keyworth's study. Certainly it will shape the context of the agency's reaction to the program initiatives resulting from the space policy review.

Question: The Soviet Union presently has a space station in orbit. Shouldn't the United States begin now to build one too?

Answer: The Soviet Union does have an orbiting space station, Salyut 6 launched in 1977, that has been manned several times for extended periods by Soviet and Soviet-sphere cosmonauts. While it appears that a manned space station would be the logical next step in the exploration and utilization of space by the United States, NASA believes that further study of a space station is warranted before a national commitment to such a project is made.