Homer E. Newell
2/6/75

FIRST DRAFT OF REPORT OF SUBCOMMITTEE ON SCIENTIST ASTRONAUTS OF NASA SPACE PROGRAM ADVISORY COUNCIL

1. Introduction

On September 20, 1973, Dr. George M. Low, Deputy Administrator of the National Aeronautics and Space Administration, sent a letter (Appendix 1) to Dr. Fred Seitz, Chairman of NASA's Space Program Advisory Council, requesting the Council to undertake a review of the effectiveness and value of NASA's scientist-astronaut program in the past, and to make recommendations on the use of scientist astronauts in the Space Shuttle Program. Specifically the charge to SPAC was to; "...conduct a critical review of the scientist-astronaut program, and of the future needs for scientist astronauts, and recommend on future steps to take in this unique type of endeavor."

Elaborating on the written charge in committee discussion, NASA stated that it would prefer to have the committee report focus primarily on recommendations as to the future use of scientist astronauts, confining the review of the past to a brief assessment of the value of the scientist-astronaut program, its successes and failures, with particular emphasis

upon the lessons learned and their implications for the future.

Responding to NASA's request, Dr. Seitz set up the SPAC Ad Hoc Subcommittee on Scientist Astronauts to carry out the review requested by NASA. The formal charter and composition of the subcommittee are set forth in Appendix 2. Meetings of the committee were held on November 4, 1974, and January 15, 1975.

At the first meeting the subcommittee heard the views and assessments of a number of people who were involved in setting up and carrying out the program, including several scientist astronauts. Following this initial review, the committee decided upon its approach to the study.

As a major input to their deliberations, the committee decided to invite written comments and recommendations from a wide range of individuals, including outside scientists who had been associated with the Apollo and Skylab Programs, other outside scientists who may reasonably be expected to be involved in the Space Shuttle Program, most of the scientist astronauts, engineers and managers involved in Apollo and Skylab, and NASA engineers and managers now responsible for the Space Shuttle Program. The list of those invited to express their views is given in Appendix 3, along with an

integrated summary of
/responses received from those who did reply.

From the letter responses a list of major considerations, was developed which served to guide the committee's discussions at its second meeting on January 15. Three of the respondents to the NASA invitation to comment were invited to join the committee in the January 15 discussions. These were Leland Belew of the Marshall Space Flight Center and Bob Parker and Joseph Kerwin, both scientist astronauts of the Johnson Spacecraft Center. In addition, John Naugle, Deputy Associate Administrator of NASA, and Chris Kraft, Director of JSC, took part in the discussions.

Out of these discussions came a series of recommendations, given in section V below.

II. Past Experience

The Gemini, Apollo, and Skylab Programs showed incontrovertibly that man can function effectively and usefully in space. His unique capabilities of judgement and adaptability make him especially valuable on many kinds of space missions. The general consensus is that, in spite of widespread doubt expressed beforehand, man in space has proven immensely valuable in the performance of scientific tasks and that

this value has increased steadily with growing experience, so that the last Apollo missions and the Skylab flights were both impressive and immensely fruitful. The scientist astronauts were particularly effective in contributing to the scientific success of the efforts on those missions on which they flew, but more than that the contributions of the scientist astronauts were essential and invaluable in the preparation for the scientific work in all missions.

Thus a first major conclusion from past experience is that not only is man in space effective and immensely valuable on a wide range of missions, but that for manned flight programs involving scientific objectives, scientist astronauts are an essential part of the total astronaut team.

A common theme in the letters received by the committee, and in the committee discussions, was the importance attributed to ready communications between the astronauts in space and scientists on the ground. It was observed that as communications improved from the early to the later missions, the fruitfulness of the scientific endeavor also increased. An appreciable number of the letters received emphasized that even better communications than in the more successful missions of the past will be required to

take full advantage of future manned scientific missions.

Just as the scientist astronauts contributed in an essential way to the preparation for a successful flight mission, so it was observed in a number of letters that much closer communications between investigators and astronauts is important to ensure full success of a forthcoming mission. While such communication did improve in the later missions, the strong views expressed emphasized that much better communicatio are absolutely necessary for the successful utilization of the Space Shuttle in the future.

A large number of letters emphasized the importance of a management arrangement for the Space Shuttle which clearly reflects and supports science and applications as prime objectives of the NASA program. It was noted that during the Gemini, Apollo, and Skylab period, scientist astronauts were included in a management arrangement that usually militated against the scientific side of the scientist astronaut's career. Some scientist astronauts observed that unusual efforts in the direction of doing science or furthering their scientific capabilities appeared to have a negative impact on their careers as astronauts because of the time it took away from working on other activities which management deemed more

important. This situation becomes very difficult to assess, since, certainly, in early developmental and experimental programs such as Gemini, Apollo, and Skylab, safety and just plain success of the flight must be paramount factors, and until one has built up enough experience to know with certainty how to achieve these, other objectives necessarily suffer. This problem was further muddied by the fact that NASA had more astronauts than it could use, particularly as previously planned flights had to be cancelled for budgetary reasons.

One finds many views and opinions on how things should have been done in the past, but there is probably little value in attempting to sort these out in all their fine detail. Rather one can go immediately to the conclusion that for the future in which science and applications objectives will be of first order in the Space Shuttle Program, it will be important to organize so that these objectives are fostered and supported, and so that scientist astronauts are enabled to maintain their scientific proficiency and to apply themselves to the science program most effectively. It will also be important to maintain the cadre of scientist astronauts at the correct size so that each scientist astronaut will be fully and properly utilized, and will be

able to have a well-rounded career in the program.

While it was felt that much can be learned from past experience, both with respect to what to do and with respect to what not to do, it was frequently emphasized that in many ways the Space Shuttle will be an entirely new experience. It will, therefore, be important to maintain an attitude of flexibility and responsiveness to evolving operational and program needs.

III. Definitions

There are several terms that will be used frequently throughout this report, and it will be important to understand clearly their meanings, since many of the major considerations bear directly on what these terms mean. The terms referred to are: scientist astronaut, commander, pilot, mission specialist, and payload specialist.

Scientist Astronaut. A scientist astronaut is thought of as an individual having a Ph.D. or equivalent in science, and who is trained as an astronaut. He is a career man, devoting his career to being an astronaut. He is research-oriented, either doing personal research or assisting other investigators in their research.

Commander. The commander is a career astronaut. He will be in command of the flight and will be responsible for the overall space vehicle operations, personnel, and vehicle safety. He will be proficient in all phases of vehicle flight, docking, and orbiter and attached payload support systems. He will be responsible for the on-orbit operation and management of attached payload support and orbiter systems. He may support/perform specific payload operations if appropriate and at the discretion of the payload sponsor.

Pilot. The pilot is a career astronaut. He will be second in command of overall space vehicle operations and will be equivalent to the commander in proficiency and knowledge of the vehicle and attached payload support systems and operations. He will be responsible for the on-orbit operation and management of attached payload support and orbiter systems. He will normally perform the payload deployment retrieval operations via the remote manipulator system and will be the second crewman for EVA operations. He may support/perform specific payload operations if appropriate and at the discretion of the payload sponsor.

Mission Specialist. A mission specialist is a career astronaut who serves as the link between the flight crew (commander and pilot) and those conducting investigations aboard the Space Shuttle mission, including payload specialists, if any. Specifically, the mission specialist will be proficient in payload (experiment) operations; he will have a detailed knowledge of the payload operations, requirements, objectives, and supporting equipment; he will be knowledgeable of orbiter and attached payload support systems and will be the prime crewman for EVA operations; and he will be responsible for the coordination of overall orbiter operations in the areas of flight planning, consumables usage, and other activities affecting payload operations. He may perform special payload handling or maintenance operations via the remote manipulator system. At the discretion of the payload sponsor, he may assist in the management of payload operations and may in specific cases serve as alternate to the payload specialist. He may be called upon to assist the commander and pilot in the event of a contingency situation during the critical launch or entry phases of a flight, or to serve as pilot during entry if either the commander or pilot becomes

incapacitated, at least to the level of calling off data, verifying checklists, etc.

Payload Specialist. A payload specialist may or may not be a career astronaut. He is the principal representative of one or more payload sponsors. He will be responsible for the attainment of the payload (experiment) objectives. The payload specialist will be an expert, proficient in payload (experiment) operations. He will have a detailed knowledge of the payload instruments and their subsystems, operations, requirements, objectives, and supporting equipment. He will be responsible for the management of payload operations and for the detailed operation of particular instruments or experiments. He must be knowledgeable of certain orbiter systems, e.g., accommodations, life support, hatches, tunnels, and caution and warning systems.

IV. Major Considerations

From their own deliberations and from the letters sent in by those invited to comment, the committee identified a number of major considerations. A summary of these considerations follows.

1. The Need for Scientist Astronauts.

A major function of the scientist-astronaut corps is to round out the overall capabilities of the total astronaut corps, and to contribute in an essential way to the planning,

preparation for, and conduct of the scientific space missions. The importance of maintaining close working relationships between scientific investigators and NASA personnel has been emphasized; a strong scientist-astronaut corps can play an essential role in establishing and maintaining a strong and effective relationship between investigators and NASA personnel. More broadly, a strong scientist-astronaut corps could be most important in bringing scientists effectively into the Space Shuttle Program, by helping to maintain good lines of communication and ways of keeping the scientific community informed of opportunities and requirements, by informing the scientists how to get into the program and to work with the system.

2. The Need for a Mission Specialist.

Since many Space Shuttle missions will involve either very complex experiments and equipments, or a complex array of many different experiments, there will be a need for careful organization and integration of the total mission effort. Where numbers of investigators are involved, as will most often be the case, the group must be welded into a smoothly working, effective team. Since this is the task expected of a mission specialist, it would appear that much, if not most, of the time a mission specialist will be required. Moreover,

when extravehicular activities, or backup for remote manipulator operations is required, a mission specialist will be needed.

3. The Need for Payload Specialists.

The payload specialist would be an expert nominated by the sponsor of an experiment, and subsequently screened and trained by NASA for flight. Whether or not payload specialists will be needed on a given mission will be determined by the sponsor and NASA as the planning and preparation for an experiment evolves. Based on past experience both on the ground and in past flight missions, it is a safe bet that payload specialists will often be desirable, and sometimes essential. This will be particularly true in cases of unusual instrumentation requirements, experiments where a succession of steps must be taken that depend on the results from previous steps, and in the case of observations where the ability to follow up quickly on observations as they unfold is important.

4. Training for Mission Specialist.

A mission specialist will be a NASA career astronaut, and his training, accordingly, a matter for NASA to determine. His initial background may or may not be in science. In either case, sufficient opportunity should be provided in

his training for him to acquire the knowledge and skills needed ~~for him~~ to interface properly with scientific investigators using the Space Shuttle and with whom he must work to develop a properly integrated team. Even when the mission specialist is a scientist astronaut, he will probably be more effective as mission specialist if his training and experience in science are broad and general, and if he is highly specialized in a particular scientific discipline.

5. Training for a Space Payload Specialist.

As the Space Shuttle Program progresses, it is likely that more and more payload specialists will come from outside the astronaut corps. NASA will have to specify what is the minimum training required to make such a payload specialist a safe, effective member of the crew. There are, however, certain arrangements that would be better than others for the training of prospective payload specialists. Presumably for a short period just prior to an actual flight, the training will have to be very intensive and full time. That cannot be avoided and should be acceptable. But in the period prior to that last intensive training, it would be most desirable to space out the training on a part time arrangement that would permit the working scientist to

continue his research during the period of training. Thus a program of training halftime through a year would probably be preferable by far over a half year's training full time.

Once an individual has gone through the payload specialist training, he is in a more or less certified category, and for second and subsequent missions his training period presumably can be much abbreviated. Also, individuals who have gone through such training may be useful, and hopefully should be willing, to help in orienting and working with prospective new payload specialists.

Finally, in many cases a payload specialist should be able and willing to assist in the operation of experiments other than his own.

6. Number of Scientist Astronauts Needed in the Program.

The number of scientist astronauts needed in the program will depend very much on the total Space Shuttle activity planned and carried out. The unfortunate experience of having too many scientist astronauts in the corps should not be repeated, but in the case of the Space Shuttle Program should not be as likely a possibility as in the Apollo and Skylab Programs. Based on current Space Shuttle plans, NASA estimates the need for 15 to 25 scientist astronauts in the corps, -- approximately

12 in 1980 and approximately 20 in 1981, for example. There are now 9 scientist astronauts in the corps, and this may drop by attrition to 6 before 1980. Thus, there will be a need to bring new scientist astronauts into the program. NASA estimates that if these new candidates are on board about the 3rd quarter of 1978, that should provide adequate time for their training.

In laying the groundwork for an ultimate selection of new scientist astronauts, NASA might want to consider a program of bringing aboard some prospective candidates in advance of the formal selection. This could be characterized as an opportunity to join NASA as science fellows, with the understanding that those who so desired would be considered as candidates for selection as scientist astronauts.

7. Spectrum of Disciplines.

As brought out above, it would appear that mission specialists should preferably be generalists. Thus scientist astronauts brought into the program for the purpose of being mission specialists should preferably have a broad scientific training and interests. They should be more experimentally and observationally oriented, rather than theoretical. Payload specialists can be used to cover other disciplines not included in the mission specialist corps, or to provide a

high degree of specialization needed for some particular experiment.

It is likely that experiments proposed for the Space Shuttle will cover a wide range of disciplines. Therefore, NASA should have a wide range of choice in selecting scientist astronauts, and the qualities of broad training and experience, broad interest, and special competence in experimenting and observation should be more important than any particular specialty. While physics, astronomy, earth and planetary sciences, atmospheric sciences and meteorology, biology, and biomedicine especially recommend themselves, there are many other disciplines that are pertinent.

8. Interpersonal Communications.

The importance of maintaining close communications between scientific investigators and those responsible for the conduct of the mission during all phases of a mission, -- planning, preparation, execution, and development of the results, -- has already been mentioned. This point was made very often, particularly by those who have had experience in the previous manned space flight program. One aspect of this was the recurring insistence on the need for more effective communications between those in orbit and scientists on the ground. This is a major area which could be assigned to scientist astronauts

as a prime responsibility.

9. Maintaining Scientific Proficiency.

Within the astronaut corps the distinguishing characteristic of a scientist astronaut is his training and experience in science. Once having decided that this training and experience in science is an important element to have in the program, it stands to reason that that scientific proficiency should be maintained. But the only way to maintain such proficiency is to engage in scientific activities. Several possibilities suggest themselves. Scientist astronauts could be provided the opportunity to do research of their own between missions in which they are operationally involved. Or periodic sabbaticals could be provided to spend a year doing research in a university or with some research group. To be effective, such a program of maintaining proficiency would have to have full commitment of NASA/making it an appropriate part of the astronauts' training program, providing the necessary opportunities and required resources. Inasmuch as the purpose would be to maintain the individual's proficiency, there should not be a requirement that the astronauts' research interestsbe narrowly constrained by NASA mission requirements. It will be important for NASA to maintain an attitude of support for science as a legitimate

element of the program. In this regard, a scientist astronaut may on occasion have an opportunity to be a principal investigator or a co-investigator, and would need NASA backing to take advantage of such an opportunity.

10. Management Considerations.

This item, as already mentioned, came up quite frequently in both the committee's own deliberations and in the communications to the committee. It was felt very strongly that NASA's organization and administrative arrangements will reflect more clearly than anything else NASA's intentions and objectives. If they are based on a clear recognition of science and applications as major objectives of the agency, that will go a long way toward establishing the climate in which the scientist astronaut can be used most effectively. If NASA management shows appreciation for and gives encouragement to developing and maintaining scientific skills, then the astronaut himself will be in the best position possible to apply his talents to the achievement of a successful space science program.

Scientist astronauts based at other centers could make unique contributions to the science programs of those other centers. At the same time, the committee felt very strongly that there should not be many NASA astronaut corps, but rather

a single astronaut corps, the management of which, including selection, training, and certification, must reside at one center, presumably the Johnson Space Center.

In the overall management arrangement, as already pointed out above, the scientist astronauts would be uniquely qualified to provide a bridge between operating people inside NASA with scientists outside NASA. Also with the proper organizational arrangement, the scientist astronauts could play a major role in keeping current users informed of what is happening, of schedules and scientific and training requirements, and can assist in making newcomers aware of how to get into and work within the system.

11. Advice on Selection of Scientist Astronauts.

In selecting new scientist astronauts for the Space/Shuttle Program, there do not appear to be any compelling reasons for following the procedure used earlier in selecting Apollo astronauts. Indeed, quite the other way. NASA now has the experience and tradition in selection and training of astronauts, and has been remarkably successful in choosing competent astronauts for flight missions. One approach that could make good use of NASA's expertise and at the same time benefit from outside expertise, would be for NASA to extend an invitation to those interested to apply to be a scientist

would
astronaut; NASA/then conduct a preliminary review and weeding out of the applications, obtain an assessment of the remaining candidates by an outside committee of experts, and finally make the selection.

V. Recommendations.

Based on the committee deliberations, inputs to the committee, and the considerations summarized in Section IV, the committee makes the following recommendations to NASA.

1. It is recommended that NASA continue and expand the scientist-astronaut corps. NASA is in the best position to estimate the number of scientist astronauts needed, but is cautioned against overstaffing, since that would lead to underutilization or improper utilization of some of the scientist astronauts. An effort should be made to include among the scientist astronauts the disciplines of physics, astronomy, earth and planetary sciences, atmospheric sciences and meteorology, biology, and biomedicine, but breadth of training, experience, and interest should weigh more heavily than expertise in a narrow specialty. In general, the scientist astronaut should be oriented more toward experiment and observation than toward theory.

2. It is recommended that NASA consider a program of NASA science fellows, to bring on board NASA potential scientist

astronaut candidates at least a year in advance of initiating a formal selection program for scientist astronauts.

3. It is recommended that, in selecting new scientist astronauts, NASA rely on its own experience and tradition in the selection and training of astronauts. The following steps are commended to NASA for consideration: (1) an invitation to prospective candidates to apply; (2) a preliminary review and screening out of unsuitable candidates by NASA; (3) an assessment of the remaining applicants by an outside committee of experts; (4) final selection of scientist astronauts by NASA.

4. It is recommended that scientist astronauts be used as mission specialists, but it appears neither reasonable nor appropriate to claim that mission specialists always have to be scientist astronauts. For any mission, the mission specialist must be given the necessary scientific background training required for him to serve his clients properly.

5. It is recommended that NASA develop a payload specialist program in which scientists or their designated representatives, after a proper course of training, can fly in the Space Shuttle for the purpose of conducting experiments. It is recommended that as much as possible of the training program be on a part time basis, so that the scientist in training as a

payload specialist can continue to pursue his scientific research during the training period. 6. It is recommended that NASA establish a specific program directed at enabling the scientist astronauts to maintain their scientific proficiency. Elements to consider in such a program are: including scientific activities as part of the training program; provision of the opportunity and necessary resources to do individual research between operational responsibilities; support of sabbaticals to universities and other research groups; support of the scientist astronaut as a principal investigator or co-investigator when the opportunity arises.

7. It is recommended that the management arrangement for scientist astronauts reflect the importance of scientific objectives to the agency, and make it possible for the scientist astronauts to be effective in helping NASA to achieve a high quality science program. It is recommended that along with their other duties the scientist astronauts be assigned responsibilities to: (1) providing a bridge between operating people inside NASA and scientists outside during planning, preparation, and execution phases of a mission; (2) fostering the most effective operational practices for the support of science, for example, improved communications between the operators in orbit and the

investigators on the ground; (3) helping to keep users and potential users of the Space Shuttle informed of NASA activities and opportunities, and assisting interested scientists in getting into and working with the system.

8. It is recommended that NASA give consideration to having some scientist astronauts based at other centers than the Johnson Space Center, in order to provide the unique support that a scientist astronaut can give to the science programs of the other NASA centers.