NASA SP-4215

FIRST AMONG EQUALS

THE SELECTION OF NASA SPACE SCIENCE EXPERIMENTS

NASA SP-4215

FIRST AMONG EQUALS

THE SELECTION OF NASA SPACE SCIENCE EXPERIMENTS

John E. Naugle

The NASA History Series

National Aeronautics and Space Administration
Office of Management
Scientific and Technical Information Program
Washington, DC 1991

Library of Congress Cataloging-in-Publication Data

Naugle, John E.
First among equals : the selection of NASA space science experiments / John E. Naugle.
p. cm. -- (NASA SP ; 4215) (The NASA history series)
Includes bibliographical references.
Supt. of Docs. no.: NAS 1.21:4215
1. Space sciences--Research--United States--History. 2. National Academy of Sciences (U.S.). Space Science Board--History.
3. United States. National Aeronautical and Space Administration--History.
I. Title II. Series. III. Series: The NASA history series.
QB500.266.U6N38 1991
500.5'072073--dc20 91-13286
CIP

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402

CONTENTS

Chapter 3
The Space Science Board

Chapter 4
NASA Organizes

Chapter 5
1959: A Year of Trouble and Conflict

Chapter 7
The Impact of James E. Webb

Chapter 8
Summary and Assessment

PREFACE

In the fall of 1957, with the launch of Sputnik I, scientists began to explore a new universe outside the Earth's atmosphere, a universe previously invisible to astronomers and beyond the reach of physicists. Scientists and the media promptly nicknamed this universe "space" and began to call the people who explored it "space scientists." In the spring of 1958, the United States created the National Aeronautics and Space Administration (NASA) and directed it to maintain U.S. leadership in space science and technology. At the same time, the National Academy of Sciences created a Space Science Board to interest scientists in space research and to advise NASA and the other federal agencies the Academy expected to be engaged in space research.

As scientists recognized the potential for major scientific discoveries in space, they began to fight for the limited opportunities to place their instruments on board NASA spacecraft. As a result of this intense competition, a quiet but equally intense struggle developed between NASA Headquarters and the Space Science Board. Each wanted to control the process to select space scientists. Inside NASA, a similar struggle evolved between NASA Headquarters and the Jet Propulsion Laboratory. It took NASA three hectic years to hammer out a selection process that was acceptable to the scientists, administrators, lawyers, procurement specialists, and the institutions involved.

Three decades later, NASA continues to use that same basic process: the associate administrator for the NASA Office of Space Science and Applications selects the space scientists for all NASA's missions. It is not a trivial responsibility. A major space science mission, such as Viking or the Space Telescope, may involve 100 scientists, require twenty years to complete, and cost more than a billion dollars. The current associate administrator recently (1989) selected the space scientists for what may become one of the most complex and costly of all NASA's scientific missions. In January 1988, he issued an Announcement of Opportunity inviting scientists to propose investigations for an Earth Observing System (EOS) to be launched in the mid 1990s. NASA plans to operate two of these systems for the next two decades. A year later, in NASA Press Release 89–15, he announced his selections. The opening paragraph of the "fact sheet" that accompanied the press release illustrates the magnitude, complexity, and nature of the NASA process for selecting space scientists:

> NASA received 455 proposals in response to the Announcement of Opportunity. Each was evaluated by scientific peers including representatives from government, academia, industry and the international Earth observation community. NASA management then selected from the ones viewed as acceptable by the peer evaluators those needed to accomplish the EOS objectives. The selection breakdown is as follows: 24 instrument investigations; 6 research facility instrument investigation team leaders and 87 team members; and 28 interdisciplinary investigators (20 U.S., 8 foreign).* The various teams selected comprise 551 different individuals from 168 different institutions, universities or laboratories in 32 different states and 13 different countries. (NASA Press Release 89–15)

Although not mentioned in the press release, it may cost over $30 billion to build and operate the two EOS platforms for two decades and to support the research of the 551 EOS space scientists. Not only is the selection of space scientists for such a mission a formidable technical and management challenge but it commits a substantial amount of government funds to a scientific mission.

In this book I describe the origin and evolution of the NASA selection process. Where necessary, I touch on the concurrent political and technical forces that helped shape the process. I have not attempted to write a comprehensive history of space science. I have not attempted to describe the process that NASA uses to formulate its scientific program, nor have I attempted to critique the qualifications of the scientists selected or the value of the research they conducted.

On March 21, 1960, at the invitation of Dr. John F. Clark, (deputy to the assistant director for Satellite and Sounding Rocket Programs) I permanently transferred from the Space Science Division of the Goddard Space Flight Center to work for him at NASA Headquarters. Initially, I was expected to work half-time for Clark and spend the other half of my time working at Goddard to finish a research project I had underway. Clark placed me in charge of NASA's Fields and Particles Program. One of my first jobs at Headquarters was to organize and chair the Fields and Particles Subcommittee of the Space Sciences Steering Committee. I chaired the Subcommittee for the first two years of its existence (1960–1962); therefore the section of this book dealing with its activities is more a personal memoir than an impersonal

* In 1989 NASA jargon, a space scientist could be, among other things, a principal investigator, a co-investigator, a team leader, an interdisciplinary investigator, or a team member, depending upon the role he or she plays in the mission.

history. Although I came to Headquarters expecting to stay at most two years, I remained there until I retired in July 1980.

In NASA jargon, the selection process has a variety of names. The lawyers responsible for NASA's procurement system sometimes refer to it as the "principal-investigator" selection process because, once selected, the scientist, or his or her institution, is awarded a contract and he or she is designated a principal investigator. NASA project managers usually call it the "payload" selection process because the suite of instruments that the scientist(s) proposed becomes the payload. Despite the different names, they all refer to the same process: the selection of the scientists to conduct experiments on a specific NASA mission.

In the spring of 1986, Dr. Sylvia D. Fries, NASA's chief historian, suggested that I write a short historical essay on the NASA selection process. I found its origins in the period immediately after World War II in the work of a small group of scientists who used captured German V–2 rockets to conduct research above the atmosphere. They created an ad hoc panel to review one another's experiments and establish the order in which they would be flown. Many of the traditions they established were later incorporated into the NASA process. Three people from this group played key roles in the formulation of the NASA selection process.

In the first five chapters, I trace the origins of space science, the Space Science Board, and NASA, and show how people, events, conflicts, forces, and decisions coalesced and led NASA to formulate its particular process in the spring of 1960. Those readers who are interested only in the details of the NASA process and the immediate circumstances surrounding its creation will find that story begins with chapter 6. I finish the story in the spring of 1962 with the NASA selection process firmly in place and the United States beginning to establish leadership in space science and technology.

NASA slightly modified the selection process between 1960 and 1962 as the leaders of the agency and space scientists gained experience. In the spring of 1961, James E. Webb became the NASA administrator. In November 1961, he reorganized the agency, created the Office of Space Science at NASA Headquarters, and placed a scientist, Dr. Homer E. Newell, in charge of NASA's space science program. Today, the NASA space science organization is much the same as the one Newell created in late 1961.

I used most of the books in the NASA History Series to help me place events in their proper chronology and context. Dr. Homer E. Newell's book, *Beyond the Atmosphere* (NASA SP–4211, 1980) covers the entire period. Newell wrote from the viewpoint of a civil servant who spent most of his professional career planning and administering space science programs. Newell was a member of the Upper Atmosphere Rocket Research Panel and later directed NASA's space science program during its first crucial years. Dr. James A. Van Allen's book, *Origins of Magnetospheric Physics*, also covers the same period. Van Allen wrote from the perspective of an academic scientist who conducted cosmic ray and magnetospheric research. He used rockets and satellites to carry his instruments above the atmosphere. Van Allen chaired the Research Panel and the Working Group on Internal Instrumentation, the group that selected the scientists for the Vanguard and the early Explorer and Pioneer missions. Dr. Robert L. Rosholt's *An Administrative History of NASA, 1958–1963* (NASA SP-4101, 1966) provided a chronology and useful insights into the events that took place before I came to NASA Headquarters. I used all three of these books extensively.

Wherever possible, however, I read the original letters, minutes of meetings, and newspaper articles to refresh my memory and to help me better recall the tenor of the time. Excellent minutes of the various International Geophysical Year (IGY) panels and working groups and of the Space Science Board, covering the period 1955 through 1962,* were available in the Archives and Records Office of the National Academy of Sciences. Valuable historical records of NASA's Space Science Steering Committee and its subcommittees and official NASA correspondence were available through the NASA History Office.

The following people were kind enough to review a draft of the manuscript and provide me with their additions, corrections, and comments: Kinsey Anderson, John F. Clark, Edgar M. Cortright, Riccardo Giacconi, Janice F. Goldblum, Frank B. McDonald, Allan A. Needell, Norman F. Ness, Marcia Neugebauer, John A. Simpson, John W. Townsend, Jr., and James A. Van Allen. Anderson, Giacconi, McDonald, Ness, and Neugebauer were young scientists in 1960, either subjected to the NASA selection process or involved in conducting the process. Clark and Cortright came to NASA Headquarters in the fall of 1958 and helped formulate the process and then used it to select space scientists for NASA's early missions. Townsend formed the Space Science Division at the Goddard Space Flight Center, helped design the process and then implemented it at that center. Simpson and Van Allen were established scientists in 1960 and members of the Space Science Board. They helped formulate the basic policies that underlay the process and were subject to the process once NASA

* The Academy does not release material in its archives until twenty-five years after the events.

began using it. Needell is a professional historian who writes about space science. Goldblum, deputy archivist at the National Academy of Sciences, checked the accuracy and format of my references to material from the Archives of the National Academy of sciences. Each read the document through and provided substantial corrections and additional material, which I have incorporated into the final version. As a result of their contributions, the document is more complete and more accurate. I am deeply grateful for the considerable time and effort these people put into their reviews. I am, however, solely responsible for the final product.

In addition to suggesting the project, Dr. Sylvia Fries edited two drafts and helped sort out those events that were of historical significance from those that were of interest to me as a participant. Lee D. Saegesser, archivist of the NASA History Office, was most patient and helpful with my requests for NASA material. Mary Ann Gaskins provided access to the minutes of the Space Science Steering Committee and its subcommittees. David Saumweber, archivist, and Janice Goldblum, deputy archivist, of the National Academy of Sciences, were most helpful, making extensive files of the International Geophysical Year and Space Science Board available and helping me find the material I wanted. Ethel Naugle edited several versions of the manuscript and helped to convert my text into readable English.

Chapter 1

THE ORIGINS OF THE SELECTION PROCESS

Early Traditions

The Upper Atmosphere Rocket Research Panel

Near the end of World War II, Germany began firing V–2 rockets into London. Although these rockets neither flattened London nor halted the Allied drive through France, it was V–2s that carried the first scientific experiments into space. In late 1945, the American Army Ordnance Department decided to test fire the remaining V–2 rockets they had captured at the end of the war. The Army offered scientists the opportunity to place their instruments in the nose of the rocket, in the location originally designed to carry explosives.

When he learned of this opportunity early in 1946, Dr. Ernst H. Krause, head of a newly formed Rocket Sonde Research Section at the Naval Research Laboratory near Washington, D.C., called together a group of scientists, described the rockets, and queried the group. Who was interested and had an experiment that might use the V–2s? On February 27, 1946, 11 of the group met at Princeton University, formed a "V–2 Upper Atmosphere Panel," and elected Krause to serve as chairman. The Panel, an informal self-constituted body, had no official status or authority. Four scientists came from military laboratories, three from universities and one from the National Bureau of Standards. Three engineers came from General Electric, the contractor the Army used to launch the V–2s. The Panel established its own objectives: to develop a scientific program, assign priorities for experiments to fly on the V–2s, and advise the Army Ordnance Department on matters essential to the success of the program. These scientists built the first crude instruments to fly above the atmosphere. From this small group of scientists using captured V–2 rockets came much* of today's complex and costly effort known as "space science." [1,2,3]

In 1947, Krause resigned; the members elected another member, Dr. James A. Van Allen, chairman, and changed the name to the "Upper Atmosphere Rocket Research Panel." Dr. Homer E. Newell, Jr., took over Krause's position at the Naval Research Laboratory and became a member of the Panel. Dr. William H. Pickering, Professor of Electrical Engineering at the California Institute of Technology, also joined the group in 1947. These three men, Van Allen, Newell, and Pickering, worked with each other in a variety of roles for the next three decades.

Van Allen, a nuclear physicist, headed a high-altitude research group at the Applied Physics Laboratory** that conducted investigations in cosmic rays, high-altitude photography, atmospheric ozone, and geomagnetism. During the early part of World War II, he helped develop the rugged vacuum tubes and circuitry that the Navy used in fuses to detonate projectiles in the vicinity of attacking aircraft or just prior to impact with a sea or land surface. This equipment, which was tightly packed into a Navy projectile and survived firing, was just the kind that scientists needed to build instruments to fly on a rocket. Raised in a small town in Iowa, educated at Iowa Wesleyan College and the State University of Iowa, Van Allen would return to the State University of Iowa in 1951 and continue to do research on cosmic rays, magnetic fields, and the aurora by using rockets launched from balloons. Whether chairman or member, he was a conscientious, hard-working member of any committee. A happy, loquacious man, always well satisfied with himself and his work, Van Allen was destined to play a major role in space science.[4]

Newell, a self-styled mathematician-turned-physicist from Holyoke, Mass., was 29 years old when he joined the Naval Research Laboratory in 1944. He had received both a bachelor's and a master's degree in mathematics from Harvard University, a Ph.D. in mathematics from the University of Wisconsin, and had taught mathematics at the University of Maryland until he joined the Naval Research Laboratory. At NRL he worked as a theoretical physicist and led a group of scientists who used sounding rockets to study the upper atmosphere. Newell practiced Christian Science, wrote children's books, played bridge, and in college enjoyed the sport of fencing. He was an extremely hard-working, well-organized individual, but very touchy about his personal turf. Like

* The SKYHOOK Balloon Program, started by the Office of Naval Research shortly after the war, also produced many of today's space scientists and many of the instruments used in space sciene.

** A laboratory operated by The Johns Hopkins University for the Navy.

Van Allen, Newell was a good committee man. He was, however, frequently frustrated with himself and his subordinates because of his inability to cope instantly and perfectly with the requests and complaints of his superiors and his scientific peers.

Dr. William H. Pickering, a tall, laconic, strong-minded ex-New Zealander, received his Ph.D. in physics from the California Institute of Technology in 1936. A cosmic-ray physicist, Pickering had gone on cosmic ray expeditions to India in 1939 and Mexico in 1941. He was to become director of the Jet Propulsion Laboratory in 1954, oversee the development of the payload for the first American satellite, and play a major role in the development of lunar and planetary unmanned spacecraft.

Van Allen chaired the Panel from 1947 to 1958. Throughout that period, the Panel operated with no formal charter, no sponsoring institution, and no source of funds; nevertheless, it became the focus of the U.S. sounding rocket program. It met regularly, four or five times a year. The Panel's membership always included at least one person from each of the institutions doing sounding rocket research. According to Van Allen, the meetings of the Panel "were a mixture of shared experiences, plans, and results and a continuous updating of schedules and assignments of payload space." [5] Although the Panel had no charter and no official status, government officials followed its recommendations just as if it were an official group charged with setting schedules and assigning payload space.

Under Van Allen's chairmanship, the Panel established a tradition of direct, candid communication among the scientists and engineers who were involved in space research. Scientists presented their proposed experiments directly to the Panel. The Panel members evaluated all experiments, including their own, criticized sloppy designs, applauded clever innovations, and, when the Panel felt an experiment was ready for flight, assigned a place for it on the launch schedule. According to Newell, "whatever control [the Panel] might bring to bear on the program was exerted purely through the scientific process of open discussion and mutual criticism." [6]

Although several members of the Panel were from Department of Defense laboratories and all used rockets developed by the military, the Panel fought, and won, a battle with DOD to keep the results of upper-atmosphere research unclassified.[7]

Through its work with rockets and meetings, this small, determined group of scientists transformed the sounding rocket into a useful research tool and learned how to allocate, on an equitable basis, the limited number of rockets available for research. The scientists who conducted the research and the agencies that provided funds for the research accepted the Panel's decisions.

During this period, the Panel established the tradition of using the most senior and most experienced scientists to plan the program, evaluate proposed experiments, and assign a priority for flight, even though this procedure meant that occasionally they evaluated their own or a competitor's proposal.

The International Geophysical Year

Unintentionally, Lloyd V. Berkner set off a chain of events that helped to create NASA and to shape NASA's space science program. In April 1950, at a dinner party hosted by Van Allen and his wife, Abbie, Berkner suggested that the world's scientists organize a third international polar year to take place during the period of maximum solar activity expected during 1957 and 1958. During the previous Polar Year (1932–1933), Berkner had served as a member of Admiral Byrd's first Antarctic Expedition. In 1950, Berkner worked for the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, where he conducted research in ionospheric physics. He also had an international reputation for building scientific institutions and organizations.[8] The dinner guests enthusiastically endorsed Berkner's idea and he and Dr. Sidney Chapman, another guest, promptly set out to make it happen.[9]

As a result of Berkner's and Chapman's efforts, in October 1952, the International Council of Scientific Unions (ICSU) established the Comité Spécial de l'Anné Géophysique Internationale, promptly nicknamed "CSAGI," to plan an International Geophysical Year (IGY). The members of CSAGI elected Chapman president and Berkner vice president.

The National Academy of Sciences-National Research Council, as the U.S. representative to ICSU, organized the U.S. participation in the IGY. On February 10, 1953, the president of the Academy, Dr. Detlev W. Bronk, formed a United States National Committee for the IGY (USNC–IGY) and appointed Dr. Joseph Kaplan, a distinguished geophysicist, chairman.

SCIGY

Even before the formation of CSAGI, the members of the Upper Atmosphere Rocket Research Panel had recognized that sounding rockets could play an important role in the IGY. Earlier, in 1952, the members of the Panel were already considering Fort Churchill, on Hudson Bay in Canada, as a likely place to launch sounding rockets to study the polar atmosphere, aurora, and low-energy cosmic rays. In January 1953, Newell proposed to the Panel that rockets be launched at northern latitudes as a part of the IGY. In October 1953, the

USNC–IGY and CSAGI approved an IGY Sounding Rocket Program and established a separate Technical Panel on Rocketry to oversee the activity. Early in 1954, Van Allen, chairman of the Upper Atmosphere Rocket Research Panel, created a Special Committee for the IGY (SCIGY) to coordinate rocket firings in Fort Churchill. According to Newell, about a year later, "hearing of the Research Council's Technical Panel on Rocketry, the panel transferred SCIGY to the Academy's technical group." After the transfer, the membership of SCIGY consisted of [10]

H. E. Newell, Naval Research Laboratory (NRL), chairman
J. W. Townsend, NRL, executive secretary
John Hanessian, Jr., National Academy of Sciences, recording secretary
K. A. Anderson, State University of Iowa
L. M. Jones, University of Michigan
Warren Berning, Ballistic Research Laboratories
R. M. Slavin, Air Force Cambridge Research Center
N. W. Spencer, University of Michigan
W. G. Stroud, Signal Corps Engineering Laboratory

Newell, Townsend, Anderson, Jones, Spencer, and Stroud all played major roles in space science, either in research or administration. According to Townsend, "It was at the SCIGY table that much of the Goddard Space Flight Center's 'culture' came into being." [11] (This Goddard culture is discussed in chapter 5.) SCIGY, with two secretaries, one working for Newell at the NRL and the other for Odishaw at the Academy, demonstrates the tension that, even at this early date, existed between Newell and Odishaw. As discussed in chapter 4, the tension would surface later in another forum, with Newell in charge of NASA's space science program and Odishaw as the executive director of the Academy's Space Science Board.

IRBMs and ICBMs

At about the same time that the ICSU decided to organize the IGY, the United States and the Soviet Union decided to build intercontinental ballistic missiles (ICBMs) to carry atomic bombs. These two quite disparate decisions ultimately opened the space age.

The development of the long-range ballistic missile created the technology, hardware, and tracking facilities needed to launch and operate scientific satellites. Even with 40 years of hindsight, it is impossible to guess when mankind, in the absence of the Cold War, would have spent the billions of dollars required to develop rockets to place spacecraft in orbit or send them to other planets.

In the mid-1950s, the United States and the Soviets raced neck-and-neck to launch the first operational ballistic missile. In addition, the Air Force, Army, and Navy competed with each other to develop their own ballistic missiles. The Air Force developed the Thor, an intermediate-range ballistic missile (IRBM), and the Atlas and the Titan, intercontinental ballistic missiles (ICBMs). The Army developed the Jupiter IRBM, and the Navy, the Polaris IRBM.

Vanguard

During 1954, the members of CSAGI recognized the possibility of using the U.S. and USSR ballistic missiles to place satellites in orbit. On October 4, 1954, CSAGI challenged the countries participating in the IGY to place small scientific spacecraft in orbit to measure solar radiation and its effect on the upper atmosphere.

The United States accepted the challenge first. On July 29, 1955, President Eisenhower announced that the United States would launch several small scientific satellites during the IGY. The Soviets waited another year before accepting the challenge. In September 1956, at a meeting of CSAGI in Barcelona, Spain, they announced that they too would launch scientific satellites during the IGY. Unlike the United States, the Soviets refused to publicly provide formal descriptions of their planned satellites, their orbits, their instruments, or their launch dates—all information essential to scientists preparing to use satellites in global research programs. They did, however, privately inform some scientists of their plans. According to Dr. John A. Simpson, who was responsible to CSAGI for coordinating measurements of cosmic rays during the IGY, Soviet scientists approached him during the same CSAGI meeting and told him the frequencies and the orbit they planned to use and estimated that they would launch in the fall of 1957.[12]

In July 1955, faced with the need to launch scientific satellites, concerned about the ICBM race with the USSR, and wanting to reduce the tensions between the United States and the USSR, President Eisenhower authorized development of a new experimental rocket, the Vanguard. He specified that the project must not use classified systems or slow the development of the military's ballistic missiles. Eisenhower's decision to build a separate rocket would delay the launch of U.S. scientific satellites and result in the Soviets being the first to launch an Earth satellite.[13,14,15] This unexpected launch of the first satellite by the "technologically backward" Soviets would generate enormous public concern and ultimately lead to the creation of NASA and to an annual budget of more than $1 billion for space science. All that, however, lay far in the future; for the moment a scientific program had to be planned and the scientists selected to carry it out.

The Technical Panel on the Earth Satellite Program

With the Vanguard Program under way, two natural questions arose: what kinds of scientific experiments could be done using the satellites, and who should do them?

Dr. Joseph Kaplan, the chairman of the USNC–IGY, chose not to use either the Upper Atmosphere Rocket Research Panel (UARRP) or the SCIGY to plan the scientific program or select the scientists for Vanguard. Instead, he created a new group, the Technical Panel on the Earth Satellite Program (TPESP), with the following members:

Dr. R. W. Porter, chairman, General Electric Company
Dr. Hugh Odishaw, secretary, National Academy of Sciences
Dr. Joseph Kaplan, chairman, USNC–IGY
Dr. Homer E. Newell, Jr., chairman, SCIGY, NRL
Dr. William H. Pickering, director, Jet Propulsion Laboratory
Dr. A. F. Spilhaus, University of Minnesota
Dr. Lyman Spitzer, Princeton University
Dr. James A. Van Allen, chairman, UARRP, State University of Iowa
Dr. F. L. Whipple, Smithsonian Astrophysical Observatory

Newell, Pickering, and Whipple were members of the Upper Atmosphere Rocket Research Panel, chaired by Van Allen. Newell, now superintendent of the Astronomy and Atmospheric Physics Division at NRL, was coordinator of the Vanguard Science Program, as well as chairman of SCIGY.

An examination of the role of the Technical Panel, its members, and its mode of operation is needed in order to understand some of the conflicting forces and people that later shaped the NASA process for selecting space scientists. Such an examination will also illuminate the milieu in which these people operated.

Kaplan assigned a major role to the Technical Panel. According to the minutes of the first meeting,[16] it was to

a) formulate the scientific program . . . .
b) delegate and direct the executions of this program.
c) establish policies and formulate procedures related to the program in the fields of budget, information policy and institutional relationships.

The Technical Panel directed work to be paid for, and conducted by, a civilian agency, the National Science Foundation, and three branches of the armed forces: the Navy, the Army, and the Air Force. Three years later, the Space Science Board would attempt to play a somewhat similar role for NASA's Space Science Program but would be displaced by NASA Headquarters.

At the first meeting of the Technical Panel, Van Allen presented a plan for the choice of scientific experiments for Vanguard. He proposed a four-step process: a scientific symposium, an invitation for proposals, a review of the proposals, and an allocation of funds and assignment to vehicles. Van Allen noted that "in view of the small number of persons engaged in this type of research and in view of the close mutual familiarity, a considerable telescoping of the above [four steps] may be possible." [17]

Although the members of the Technical Panel discussed the possibility of a formal solicitation of proposals for Vanguard at its next several meetings, no such solicitation was ever made. For instance, Dr. John A. Simpson, who was active in the IGY, did not receive an invitation to propose experiments for Vanguard and apparently was unaware of the existence of the Technical Panel until its last meeting in May 1958, when it approved his proposal to fly a cosmic ray detector on a Pioneer II.[18] Although there was no formal solicitation of proposals, in January 1957, the Upper Atmosphere Rocket Research Panel sponsored a symposium to study the usefulness of the satellite for scientific research. Papers describing the satellite, proposed experiments, and the process for submitting proposals were presented at this symposium.[19]

On November 21, 1955, at the second meeting of the Technical Panel, Newell presented a set of scientific experiments proposed by Project Vanguard for the first Vanguard satellite. After some discussion, the Panel decided to accept Newell's proposals with the understanding that, while work would proceed on them, if better proposals were received they might be substituted for the Newell proposals. According to the minutes, the Panel also "resolved to defer discussion and action on Cosmic Ray instrumentation proposals received by Dr. Van Allen . . . and Dr. Singer of the University of Maryland until its next meeting." [20]

On January 23, 1956, at its third meeting, the members of the Technical Panel unanimously approved a motion to form a Working Group on Internal Instrumentation (WGII). The charter for the Working Group directed it to review proposed experiments and recommend their relative priority to the Technical Panel. Porter appointed Van Allen as chairman of this group and asked him to select the members.[21,22]

The Selection of the Vanguard Experiments

On March 2, 1956, Van Allen assembled the Working Group for the first time. The members were

Dr. J. A. Van Allen, chairman
Dr. L. R. Alldredge, ORO
Dr. M. Ference, Jr., Ford Research Laboratory
Dr. H. Friedman, Naval Research Laboratory

Dr. W. W. Kellogg, Rand Corporation
Dr. Hugh Odishaw, secretary of the Technical Panel
Dr. R. W. Porter, chairman of the Technical Panel
Dr. L. Spitzer, Princeton University

At that meeting, the members formulated the following criteria to be used to evaluate proposals: scientific importance, contribution to the knowledge of the environment in space, technical feasibility, competence of the proposer, and the need to fly in a satellite to accomplish the proposed research. Using these criteria, the Working Group evaluated fifteen proposals, arranged them in the order in which they thought they should fly, and submitted their recommendation to the Technical Panel. The first four experiments on their list of priorities are of interest because they were the ones ultimately chosen by the Panel to fly on the Vanguard satellites. These four experiments were [23]

ESP–8 Satellite Environmental Measurements, H. E. LaGow, Naval Research Laboratory (NRL)
ESP–9 Solar Lyman-Alpha Intensity, H. Friedman, NRL
ESP–11 Proposal for Cosmic Ray Observations in Earth Satellites, J. A. Van Allen, State University of Iowa
ESP–4 Proposal for the Measurement of Interplanetary Matter from the Earth Satellite, M. Dubin, Air Force Cambridge Research Center.

On March 8, at the fourth meeting of the Technical Panel, Newell introduced a motion to approve the Working Group's report. This motion also directed Van Allen to inform those who had submitted proposals where they stood on the Flight Priority Listing and requested that the Working Group consider any additional proposals received. The motion was unanimously approved. Although it established the priorities of these four experiments, it did not assign them to a specific flight.

Newell, as Vanguard Science Program coordinator and undoubtedly under pressure from the Vanguard project manager to provide a firm payload for the first satellite, then introduced the following motion: [24]

> The Technical Panel of the Earth Satellite Program authorize the Naval Research Laboratory to firm up proposed experiments ESP–8 and ESP–9 with the understanding that these experiments will be carried on the first flight.

After some discussion, during which Chairman Porter first stressed the importance of making a firm decision on the experiments for the first satellite at this time and then reconsidered and decided that it would be better to reserve some freedom of action regarding such decisions, the Panel rejected this motion. A weaker motion, stating that "it is the intent of the Panel at the present time that ESP–8 and ESP–9 be mounted on the first flight," was also voted down. The Technical Panel then resolved to have Van Allen write letters to the chairmen of all the technical panels of the United States National Committee for the IGY asking them to suggest other experiments.

Additional proposals continued to come in until by the end of May there were twenty-five. On June 1, 1956, Van Allen reconvened the Working Group. He invited the leaders of the groups preparing instruments to join the first half of the meeting to discuss "common technical problems" and problems with experiments or with the Vanguard project. After this joint discussion with the proposers, the Working Group finished its evaluation of the proposals and recommended that four of the twenty-five proposals be placed in Flight Priority A and six be placed in Flight Priority B, with the understanding that the first "few" Vanguard vehicles would be assigned to those in flight priority A. The four experiments in Flight Priority A were the first four experiments on the priority list developed by the Working Group at its first meeting and were later approved by the Technical Panel for flight.[25,26]

Several things are significant about the operation of the Technical Panel and its Working Group. The Technical Panel, a group established by the National Academy of Sciences, selected the scientists for the Vanguard Program. Even though NRL was responsible for the Vanguard Program, it could not proceed with the integration of instruments until those instruments had been approved by the Technical Panel. Money could not be released from IGY funds to the scientists until the Technical Panel had approved their proposals.

The Technical Panel and the Working Group followed the pattern established by the Upper Atmosphere Rocket Research Panel. There was open discussion of the merits of the proposals. Those who had prepared proposals came before the Working Group to discuss their proposals. Van Allen and Friedman each had proposals under consideration. Both were members of the Working Group. Newell, a member of the Technical Panel and the Vanguard Science Program coordinator, was also the supervisor of the NRL scientists, LaGow and Friedman, who had proposed the first two experiments on the Technical Panel's priority list. Clearly, Newell, Van Allen, and Friedman all had a vested interest in the decisions of the Technical Panel, yet there was no concern about a conflict of interest. They were evaluating proposals and assigning them a flight priority in the same way they had started doing it in the Upper Atmosphere Rocket Research Panel back in 1947. The few Vanguard satellites needed to be assigned to the groups who, in their collective judgment, had the best scientific experiments and were most likely to be able to produce a workable instrument in time for launch. Later, when there were many more space scientists competing for the opportunity to fly their instruments in space—many of them young scientists desperately trying to break into space science—the idea of scientists evaluating their own and their competitors' proposals would loom as a major conflict of interest.

In the spring of 1956, however, conflict of interest was not an issue, and neither was time. The Technical Panel could leisurely debate who should be invited to submit proposals, consider motions and postpone decisions for a month or two. The Technical Panel was under no strong pressure to complete its work. As long as the Vanguard satellites were launched before the IGY ended in December 1958 all would be well. The Soviets had not yet committed to launch a satellite as a part of the IGY.

Although Vanguard was supposed to be a scientific, not a military, program, scientists from military laboratories proposed three of the four top-priority experiments. A military laboratory, the Naval Research Laboratory, managed all other aspects of the program, the satellites, the launch vehicles and the tracking stations. The Department of Defense funded all experiments except Van Allen's, the lone university experiment, which was funded by the National Science Foundation.[27]

At their June 1956 meeting, the members of the Working Group and those proposing experiments shared one common technical concern: how realistic was the launch schedule? Could the Vanguard rocket place a satellite in orbit before the end of the IGY in December 1958? It was a natural technical concern in June; three months later it would become a crucial issue when the USSR announced that it intended to launch scientific satellites during the IGY. A year later the Soviets launched Sputnik and brought to an end the leisurely, close-knit world of the Upper Atmosphere Rocket Research Panel, SCIGY, and the Working Group on Internal Instrumentation.

The work of these groups, UARRP, SCIGY, TPESP and WGII—conducted prior to 1958 at a time when money was tight, rockets were small and unreliable, their work largely ignored by the press and the public, and all the space scientists in the United States could gather in one small room—provided a solid, essential background for the halcyon years immediately after Sputnik. Following Sputnik, money poured in, satellites grew enormous and complex, rockets became large but still unreliable, and the launch sites were overrun by congressmen and TV reporters. Suddenly, a multitude of scientists who had never laid a hand on a rocket began to elbow their way through the corridors of Washington hunting for a rocket to shoot their pet experiment into space.

Sputnik!!

The National Academy of Sciences hosted a meeting of CSAGI in Washington the first week in October 1957. American scientists attending the meetings were irritated by the Soviets' continued refusal to divulge any information about their satellite and became apprehensive. Rumors had it that a Soviet launch was imminent whereas the launch of the first Vanguard scientific satellite was still nearly six months away. However, despite the urging of their CSAGI colleagues throughout the week of the meeting, the Soviet scientists remained steadfast in their refusal to disclose any information on the instrumentation or the launch date.

At the end of the week, on Friday night, October 4, 1957, Berkner, now president of the International Council of Scientific Unions, attended another dinner party, this one hosted by the Soviet Embassy in Washington for the members of CSAGI. During the course of the evening, a reporter from the *New York Times* spoke briefly to Berkner, who then rapped his glass for attention and began to speak. "I wish to make an announcement. I am informed by the New York Times that a satellite is in orbit at an elevation of 900 kilometers. I wish to congratulate our Soviet colleagues on their achievement." [28]

The Impact of the Sputniks and the First Vanguard

Sputnik I

The unexpected launch of Sputnik I produced a major upheaval in American science and engineering. Moscow radio announced the news on a Friday evening, and within hours virtually every American ham radio operator, physicist, and radio astronomer from Boston to San Diego, and on ships at sea, was either listening or feverishly assembling equipment to listen to Sputnik's beeps.[29,30] Newspapers and radio stations carried the time and direction for people to watch Sputnik as it passed overhead. Over the weekend, nervous groups assembled in backyards and on hillsides to speculate on the significance of the faint, man-made star, one that crossed from horizon to horizon in minutes. Americans left work Friday evening as Earth-bound humans to return on Monday, still Earth-bound, but living in a new age, the space age.

The surprise launch of Sputnik profoundly affected American scientists and engineers involved in space research. Frustrated scientists, thanks to their Soviet colleagues' secrecy, did not have instruments ready to receive Sputnik's radio transmissions. Chagrined aerospace engineers had to answer the same nasty question over and over: How could the Soviets, who had apparently started work a year after the Americans, launch a satellite weighing six times as much as Vanguard? Their frustrations were just beginning, and none, not even far-sighted Berkner, anticipated the growing anger and impatience of Americans as they settled down before their television sets to watch the United States and the Soviets race to see who would become the leader in space.

Sputnik II

They did not have long to wait. A month later, on November 3, 1957, the Soviets launched Sputnik II, a half-ton satellite that carried a female dog, Laika, into orbit. Although Sputnik I shocked and irritated Americans, it did not particularly frighten them. Assured by the President and the media, they believed a U.S. satellite would have been first if Eisenhower had permitted the use of classified military rockets. Annoyed that the Soviets were "first into space," they were still confident that U.S. technology was far ahead of that of the USSR.

Sputnik II, however, shocked everyone. It weighed more than 1000 pounds and carried a dog. Neither of the big rockets under development, the Atlas or the Titan, could orbit a 1000-pound payload. Highly classified reconnaissance satellites, with reentry capsules to recover their film, were under development, but the United States had not started to develop a spacecraft with a life support system. Most aerospace engineers regarded Laika's flight as a precursor to manned flight. Clearly, the USSR had demonstrated that it was ahead of the United States in manned space flight and in the size of satellites that it could place in orbit.

Let The Race Begin

The media, the politicians, the "military-industrial complex," and the scientists immediately began to exploit the public concern about "space," each for its own purpose. A steady chant arose: "When are we going to catch up with the Russians?" This chant did not stop until Neil Armstrong stepped on the Moon in 1969. Then it was abruptly replaced with a new theme: "Let's stop wasting all this money on space."

On November 7, 1957, two days after the launch of Sputnik II, President Eisenhower, in an attempt to quiet the public clamor, announced that the United States had successfully tested a reentry nose cone. He also named Dr. James R. Killian* to the newly created

* President of the Massachusetts Institute of Technology

post of Special Assistant to the President for Science and Technology.[31]

After Sputnik II, President Eisenhower abandoned his policy of using only Vanguard to launch satellites. On November 8, 1957, Secretary of Defense Neil McElroy directed the Army to launch an IGY scientific satellite using a modified Jupiter C launch vehicle.* [32] On December 5, McElroy announced the formation of a new Advanced Research Projects Agency (ARPA) that would direct all defense-related space activity. For the next ten months, until NASA began operation in October 1958, ARPA managed all U.S. space activity, civilian and military.

The Congress, controlled by the Democrats, responding to the public clamor after the first two Sputnik launches, turned the "loss of leadership in space" into a major political issue. Immediately after the second Sputnik launch, the Military Preparedness Subcommittee of the Senate Committee on Armed Services, chaired by Lyndon B. Johnson, held 20 days of hearings on the subjects of satellites and missiles.[33]

The First Vanguard Fails

On Friday, December 6, a month after the launch of Sputnik II, assorted dignitaries, reporters, and TV cameramen confidently assembled at Cape Canaveral to watch the launch of the first American satellite. Seconds into the launch, in horrified disbelief, they saw the rocket burst into flames, crumple and dump the satellite back onto the launch pad. Over the weekend, Americans watched replays of the crumbling rocket and saw the little satellite bounce on the pad. The Soviets had led the world into the space age and the Americans could not even follow. Not since Pearl Harbor, sixteen years before, had American pride and prestige suffered such a blow.

These three events—two successful Sputnik launches, followed by the failure of the first Vanguard launch—unleashed a mighty effort on the part of American scientists, engineers, and politicians to try to restore American pride and prestige. Even American taxpayers seemed willing to dig into their pockets to pay for the technical effort necessary to beat the Soviets. If the December launch of Vanguard had been successful, the hysteria might have died down over the Christmas vacation, but the Sputniks succeeded, Vanguard failed, and Americans would not rest until they led the world in the exploration of space. As 1958 began, the question was not whether the United States should try to catch up with the Soviets, but what needed to be done and how quickly it could be accomplished.

* The Jupiter C was the vehicle that the Army had developed to launch satellites. When the President selected the Navy's Vanguard to launch the scientific satellites, the Army began using the Jupiter C to test nose cone reentry techniques.

Stress on the Selection Process

In early 1958, the burgeoning interest of scientists, the effort to protect the security of classified launch vehicles, and the pressure to get something into orbit brought some new and unhealthy criteria into what rapidly became a confused and confusing selection process.

Selection of the Scientists for the Explorers

The Technical Panel on the Earth Satellite Program (TPESP) and its Working Group on Internal Instrumentation (WGII) selected the scientists for Explorer I. Dr. William H. Pickering played a major role in selecting them. Pickering, director of the Jet Propulsion Laboratory, under an extremely tight deadline to deliver the payload for the Army launch in January, badly needed instruments that would produce useful data, were compatible with the Jupiter C, and could meet a January launch schedule. Consequently, he took the lead role in reviewing the status of the instruments under development for Vanguard. The Technical Panel selected Dr. James A. Van Allen to furnish an instrument to measure cosmic rays, Maurice Dubin of the Air Force Cambridge Research Laboratory to furnish a meteoritic dust detector, and JPL to furnish temperature sensors. Both Van Allen's and Dubin's instruments had already been proposed for the Vanguard Program, evaluated by the Working Group, and placed in Category A by the Technical Panel. Other scientists had no time or opportunity to propose experiments for the Army's Explorer Program.

Actually, Pickering and the Panel had little or no choice. Back in November, when Neil McElroy, Secretary of Defense, directed the Army to launch Explorer I, he had also promised the President that Major General John Bruce Medaris* and Wernher von Braun** would launch their satellite within 90 days—leaving no time to solicit proposals or develop new instruments. Van Allen's cosmic ray instrument existed and had been designed to operate either on a Vanguard or a Jupiter C rocket. A year earlier, Dr. Ernst Stuhlinger, chief scientist for the Redstone Arsenal, who served on the Upper Atmosphere Rocket Research Panel, informed Van Allen of the successful flight of a three-stage version of the Jupiter C rocket. Van Allen then decided to cover both possibilities by designing his experiment to fly on either the Vanguard or the Jupiter C rocket. Now, faced with an opportunity to fly

---

* Commander of the Army Ballistic Missile Agency located at the Redstone Arsenal in Huntsville, Alabama.

** Leader of the team of German engineers who developed the original V–2 rockets and now leader of the German scientists and engineers responsible for developing the Jupiter IRBM and the Jupiter C at the Arsenal on the Jupiter C, Van Allen had a difficult choice; he could stay with the Vanguard program or give up his place in that program and gamble on Von Braun and the Jupiter C. He chose, rightly, to go with the Jupiter C.[34,35,36]

Von Braun's group launched Explorer I January 31, 1958. On March 5, they attempted to launch Explorer II, but failed. On March 26, Explorer III, containing a tape recorder, reached orbit. Using the tape recorder to record radiation data over the entire orbit, instead of just over the tracking stations, Van Allen established the existence of radiation belts, a doughnut-shaped region of very intense nuclear radiation around the equator of the Earth. On May 1, 1958, Van Allen announced the existence of these belts at a meeting at the National Academy of Sciences. These "Van Allen Belts," a new, unexpected, and exciting scientific phenomenon, posed a hazard to the flight of humans and civil and military spacecraft, caught the media's attention, and demanded further investigation.

Shortly after Van Allen's discovery of the belts, the Advanced Research Projects Agency (ARPA) approved two more satellites, Explorers IV and V, to study the radiation that would result from a series of classified high-altitude nuclear explosions planned for July–August 1958. Based on the success of Explorers I and III, ARPA and the Atomic Energy Commission selected Van Allen to build the instruments for IV and V. The success of Explorer I and Van Allen's unexpected discovery of the radiation belts, combined with the failure of the Soviet scientists to announce any significant results from Sputniks I and II, restored some of the wavering self-confidence of American scientists. They now began to look for other phenomena that might be awaiting discovery out in space.

In addition to the discovery of the radiation belts, Van Allen, and his hard-working graduate students at the State University of Iowa, made another valuable contribution to space science. They demonstrated, clearly and unequivocally, that a university physics department could design and build instruments that would operate in space and produce significant scientific results. University scientists who contemplated a career in space science realized that they would not have to go to a federal laboratory or have their instruments built by an aerospace contractor.

Selection of the Scientists for the Pioneers

Meanwhile, the race with the Russians took a new turn. The leaders of ARPA, in an effort to recapture the lead in space exploration, decided to try to beat the Soviets to the Moon. Early in 1958, they approved work on five "Pioneer" missions. The Pioneers, spacecraft designed to fly by, or crash into the surface of, the Moon, were originally designed to carry small television cameras to transmit back pictures of the surface of the Moon. The difficulty, however, of building a camera that would be small enough to fit in the payload space of a Pioneer and ready in time for a launch in the fall of 1958, led to a change in plan. Instead, because of the acute interest in the recently discovered Van Allen belts, ARPA decided to select experiments for the Pioneers that would determine the outer boundaries of the belts and measure the radiation levels in the region between the Earth and the Moon.[37]

ARPA assigned responsibility for two of the five Pioneer missions to the Army and three to the Air Force. The Army naturally turned to the Explorer team, Von Braun's group, for the Jupiter C, JPL for the spacecraft, and Van Allen for the instruments. The Air Force turned to its Space Technology Laboratory * (STL) in Los Angeles, California to develop and launch its three Pioneers. Although the Air Force asked Dr. Hugh Odishaw ** to suggest scientists who might want to fly experiments on the STL Pioneers, there is no record of any formal solicitation by the Academy's Panel, or by ARPA, the Air Force, or STL.

An experiment by Dr. John A. Simpson, cosmic ray physicist from the University of Chicago, was reviewed and approved by the Academy's Technical Panel on the Earth Satellite Program (TPESP). Simpson's own words provide a vivid picture of the hectic situation and the speed with which decisions were made, money found, and instruments prepared in the spring of 1958:[38]

> By early 1958, I had a design, some prototype instrumentation and, in May 1958, visited Washington, D.C., where I talked with Hugh Odishaw. He pointed out that a meeting was being held the next day (an Academy panel),*** which I learned was a mixture of personnel including people from ARPA.
>
> That night at the Cosmos Club I immediately prepared a draft proposal in the form of a series of sheets using the back side of the Cosmos Club correspondence paper and brought it with me to the meeting. I showed the Review Committee what I wanted to do in the way of an experiment which would decide the heliocentric character of solar modulation and confirm our early work on the discovery of the heliosphere. This led to our being given about 50% of the space of the payload capabilities for Pioneer-2 and I went home that night elated that we were now at last getting into business.

---

* The Air Force had established the Space Technology Laboratories to provide technical help in the development of ballistic missiles.

** Odishaw at this time was the executive secretary of the United States National Committee for the IGY (USNC-IGY) and a member of its Technical Panel on the Earth Satellite Program (TPSEP).

*** The Working Group on Internal Instrumentation.

> To finance the experiment, I had a budget proposal submitted to Homer Newell's * office. By 16 June 1958, I had the confirmation of funding for the experiment and by the end of June I had hired C. Y. Fan who, along with Peter Meyer, worked with me throughout the summer to prepare the experiment integrated by STL and launched in November on Pioneer-2.

Simpson presented his proposal to the Working Group at its tenth and last meeting. The minutes in the Academy Archives consist of only two handwritten pages. The final entry reads "Endorses Simpson Exp I for moon shots."[39] The next day, May 27, 1958, Porter held the eighteenth, and final, meeting of the Technical Panel and approved Simpson's experiment.

At this same meeting, the members of the Technical Panel discussed future space science programs. Porter reported that only $4000 remained in the satellite budget. Someone reported that the president of the Academy intended to do something about the continuing space science program. The Technical Panel's IGY mandate and its funding had run out. Congress was busily passing legislation to create a new space agency. A month later, the newly formed Space Science Board would take over the work of the Technical Panel and its Working Group on Internal Instrumentation.[40]

ARPA also chose Dr. John Winckler from the University of Minnesota, to prepare another radiation experiment. There is no record that Winckler's experiment was reviewed by the Working Group. Winckler, however, was an experienced cosmic ray physicist. ARPA chose two STL scientists, Dr. Charles P. Sonett and Paul Coleman, to fly a magnetometer to measure the magnetic fields in space. Neither Sonett nor Coleman were, at that time, established scientists working in space science. There is no record that their proposal was reviewed by the Working Group. There were groups at the Naval Research Laboratory and in Van Allen's group at the State University of Iowa who had used rockets to carry magnetometers to study the Earth's magnetic field. The major reason for choosing Sonett and Coleman over these established groups seems to have been their proximity to the spacecraft project at STL.

According to the minutes of the Space Science Board, STL treated Simpson and Winckler as if they were ordinary industrial contractors, which irritated them. In addition, STL's treatment of the scientists jeopardized the quality of their research.** STL engineers argued that

---

* Dr. Homer E. Newell at this time was superintendent of the Atmosphere and Astrophysics Division at the Naval Research Laboratory, a member of TPSEP, and chairman of its budget committee.

** See discussion of the third meeting of the Space Science Board, page 93.

they, rather than the scientists, should build the flight instruments. Simpson, however, insisted that he build and test his own instruments. After his interaction with STL, Simpson decided that in the future he would design the circuits and build all of his instruments in the Fermi Laboratory at the University of Chicago. He organized his laboratory so that he controlled the integration of his instruments into spacecraft. Thus, he could be sure that they worked properly in space.[41]

ARPA's haphazard selection of the Pioneer experimenters and STL's treatment of the two university scientists helped convince many scientists that the selection process and the management of space science missions must be held firmly in the hands of civilian scientists and not delegated to industrial contractors or aerospace engineers.

In summary, the selection process used by the Academy to select the experimenters for the Vanguard mission began to break down during the Pioneer missions under the mounting pressure to get something to the Moon ahead of the Soviets. The process whereby the Working Group solicited proposals, albeit informally from a small select group of scientists, and then evaluated those proposals against specific criteria, was replaced by a process in which personal acquaintance, experience with rockets, the ability to get clearance to work with classified launch vehicles, and proximity to the manufacturer of the spacecraft, as well as the scientific merit of the proposed experiment, began to influence the selection of space scientists. In the spring of 1958, a scientist coming to Washington to get an experiment flown found a very confusing situation. Where did one go to find a place to fly one's instrument—ARPA, the National Academy of Sciences, STL, one of the Military services, or the embryonic NASA?

Chapter 2

THE ORIGINS OF NASA

Meanwhile, during the early part of 1958, as the Explorers flew and ARPA struggled to beat the Soviets to the Moon, powerful forces in Washington vied for control of the burgeoning space program.[42]

A National Space Establishment

One of the more powerful and better organized of these forces was the Upper Atmosphere Rocket Research Panel. In April 1957, the members had changed the name of their panel to the "Rocket and Satellite Research Panel." By December 1957, they had doubled their membership and begun to promote a concept they called a "National Space Establishment." On December 27, 1957, the Panel issued a report, *National Space Establishment, A Proposal of the Rocket and Satellite Research Panel*. The proposal called for the United States to create a "National Space Establishment for the purpose of carrying out scientific exploration and eventual habitation of space." The Panel proposed that this Establishment be an independent agency, unless that would take too long. If so, the Panel recommended that the Secretary of Defense be in charge, rather than one of the three services. Although there were many other powerful forces in Washington struggling to shape the nature of the burgeoning space program, the Panel's report and the concerted lobbying of its members undoubtedly played a key role in shaping NASA.[43]

The NACA Becomes the Space Establishment

Early in 1958, the Executive Branch and the Congress began to organize to reclaim American leadership in space. In February, the Senate created a Special Committee on Space and Astronautics, chaired by Senator Lyndon B. Johnson, and the House created the Select Committee on Aeronautics and Space Exploration, chaired by

House Majority Leader John W. McCormack.[44] Several organizations began to lobby these committees and the Administration to win control of the space program. Senator Clinton Anderson, chairman of the Joint Committee on Atomic Energy, proposed amending the Atomic Energy Act in order to give the Atomic Energy Commission a major role in space. The Jet Propulsion Laboratory in Pasadena, California, which was building Explorers I, II, and III, lobbied to became the national space laboratory.

On January 14, 1958, a small, well-known (in aeronautical circles), and highly respected aeronautical research organization, the National Advisory Committee for Aeronautics, better known as the "NACA," issued a carefully crafted plan for its participation in the space program entitled "A National Research Program for Space Technology." (The nature of the NACA and the work that underlay this report are discussed below.)

On February 4, 1958, the President asked his new special assistant for Science and Technology, Dr. Killian, for a plan for space exploration. On March 5, Killian, Nelson Rockefeller, chairman of the President's Advisory Committee on Government operations, and Percival Brundage, director of the Bureau of the Budget, delivered a memorandum to the President recommending that "leadership of the civil space effort be lodged in a strengthened and redesignated National Advisory Committee for Aeronautics."

President Eisenhower accepted the recommendation and ended the rampaging competition when he announced that the NACA would lead the Nation's space program.[45,46] He also announced his intention to submit the necessary legislation to Congress to convert the NACA into the National Aeronautics and Space Administration (NASA). He submitted this legislation to an eager Congress on April 2, 1958.[47]

Both houses of Congress promptly began hearings on the proposed legislation, and on June 2, 1958, early on a Tuesday morning, John W. McCormack, House Majority Leader and chairman of the House Select Committee on Astronautics and Space Exploration, charged onto the floor of the House with his version of the National Aeronautics and Space Act of 1958. The Senate acted with equal speed and on July 29, the President signed into law the National Aeronautics and Space Act of 1958.

The Space Act of 1958 bore little resemblance to the limited, carefully crafted plan that the NACA had issued on January 14, 1958; and even the preparation of that limited plan had caused considerable controversy within the NACA, the "good grey" aeronautical research organization, created during World War I.

The Legacy of the NACA

In March 1915, the NACA consisted of a committee with twelve unpaid members and one full-time clerk, John F. Victory. In the fall of 1957, forty-two years later, the NACA still had its unpaid committee and John F. Victory. But now it employed 8000 people, operated three research laboratories and two field stations,* and was a highly respected aeronautical research organization. The "Main Committee" elected its own chairman, who then appointed three permanent civil service employees, the "big three" of the NACA: the director, the executive secretary, and the associate director for research. Famed Air Force General James Doolittle chaired the Main Committee. John F. Victory, the original clerk now with forty-two years of service, served as executive secretary. Dr. Hugh L. Dryden, an outsider and relative newcomer with only ten years of service, was director. Dryden, a physicist with a Ph.D. from Johns Hopkins, came to the NACA from the National Bureau of Standards and spent several of his early years fighting Victory for control of the organization.[48] In the fall of 1957, with this battle behind him, Dryden firmly controlled the NACA. The military, the aerospace industry, and Congress respected Dryden as an able, tight-fisted administrator, one who usually returned a little of the NACA's annual appropriation to the Treasury. Equally well respected by the Washington scientific establishment, he was a member, and served as home secretary, of the National Academy of Sciences.

At this time, the NACA and its Main Committee functioned as a largely self-sufficient organization. The Main Committee dealt with the external world, handled political and industrial pressures, appointed the "big three," and approved the research program. The "big three" dealt with the internal world of research, administration, budget, and facilities. The NACA trained its people, operated its research facilities with civil servants, and published the results of its research in the NACA's own yellow-covered research journals. Only 35 percent of the NACA program supported the development of space technology: the rest supported aeronautical research.

The launch of Sputnik I irrevocably changed the "good, grey," practical, aeronautical research world of the NACA. A year later, its

---

* Langley Memorial Aeronautical Laboratory, Hampton, Virginia; Ames Aeronautical Laboratory, Moffett Field, California; Lewis Flight Propulsion Laboratory, Cleveland, Ohio; Pilotless Aircraft Research Station, Wallops Island, Virginia; and High Speed Flight Station, Edwards Air Force Base, California.

successor, NASA, would be planning to orbit giant telescopes, send spacecraft to the planets, and land men on the Moon.

The NACA Approach to Space

The public clamor to catch up with the Soviets, which began in earnest after the launch of Sputnik II, created a dilemma for Doolittle and Dryden. If they competed for and won the space program, they knew they would have to substantially change the character of the NACA, and a number of its senior people did not want to change the character of the NACA. If the NACA remained an aeronautical research agency, it could lose substantial numbers of people, possibly a laboratory, and certainly its flight test facilities would go to the agency that captured the space program. If it took over the space program, aeronautical research would take a back seat to space research, the agency would have to take on the burden of administering large industrial contracts, and it might find itself competing with, rather than cooperating with, its old partner, the Air Force.

Early in December, in order to resolve this dilemma, Dryden invited the directors and associate directors of the three NACA laboratories to come to Washington to discuss the NACA's approach to space. Smith DeFrance, director of the Ames Laboratory, opposed any move into space activities, arguing that it would destroy the whole concept on which the NACA was based. Henry J. E. Reid, director, and Floyd Thompson, associate director of Langley, although not enthusiastic about space research, did not oppose it. Abe Silverstein, associate director of Lewis, enthusiastically argued that the NACA should take a major role in the space program.

After this meeting, Dryden turned to the young people in the NACA to get their view. On December 18, 1957, immediately after the meeting with the senior managers, Doolittle hosted a dinner in Washington for the younger people in junior levels of management who were most likely to become the leaders of the agency in the decades ahead. Doolittle and Dryden deliberately excluded their supervisors from the dinner in order to get the authentic, unvarnished opinions of these young people. Dryden presented the options facing the agency and asked them whether the NACA should remain as it was or pursue the space program. The young people responded overwhelmingly in favor of strong NACA participation in space. The NACA could, they said, contribute to the national space effort and would benefit from its participation in terms of challenge, and additional people, facilities and funds.[49,50]

After all these deliberations were over, the NACA issued its January 1958 report: "National Research Program for Space Technology." Dryden supervised the preparation of the plan and it reflected his approach to space. It did not call for a new agency. Instead, it proposed a cooperative space program to be conducted by several existing agencies. Under the plan, the NACA would double its staff, create a new space research laboratory, accelerate its flight program, and increase the amount of research that it supported at other institutions. The DOD would handle large flight projects, and the National Academy of Sciences and the National Science Foundation would be responsible for planning and funding the space science program, most of which would be conducted by academic scientists. Dryden's plan preserved the NACA's role as a developer of technology, while it expanded that role to include space as well as aeronautical technology. It kept the NACA in its traditional role as DOD's partner in the development of space technology. It kept the NACA out of the development and procurement of major spacecraft, out of operations, and out of space science. Dryden's plan had something for everybody—except for those people who felt that the only way to catch up with the Soviets was to give one agency the authority, responsibility, and all the facilities, people and resources needed to overtake them—and those were the people who shaped the Space Act.

Few of the NACA recommendations for the organization of the space program were incorporated into the Space Act passed by the Congress in 1958.[51]

The National Aeronautics and Space Act of 1958

The Space Act created a civilian space agency and gave it certain objectives. It did not create a space science program. What it said, and what it did not say, about space science strongly influenced the immediate reaction of the National Academy of Sciences. The Act give the NASA administrator almost complete control over the civilian space science program.

As written by a group under the Bureau of the Budget and amended by Congress, the Act was a carefully crafted document that specified certain policies and procedures and left others deliberately ambiguous.[52,53] The ambiguities provided room for the administrator of NASA and his staff to maneuver and capitalize on the opportunities and to deal with problems that those who drafted the document could not foresee.

The Preamble to the Space Act states that it is

> An act to provide for research into problems of flight within and outside the earth's atmosphere, and for other purposes.

The Preamble does not mention space sciences except in the tacked-on "for other purposes" part of the statement. Fortunately, other parts of the act specify the "other purposes" and provide strong justification for a vigorous space science program.

In Section 102, "Declaration of Policy and Purpose," the Act states

> The Congress declares that the general welfare and security of the United States require that adequate provision be made for aeronautical and space activities.

Further, the Act describes the kinds of activities and their purpose: [54]

> The aeronautical and space activities of the United States shall be conducted so as to contribute materially to one or more of the following objectives:
>
> (1) The expansion of human knowledge of phenomena in the atmosphere and space.
>
> . . . .
>
> (5) The preservation of the role of the United States as a leader in aeronautical and space science and technology and in the application thereof to the conduct of peaceful activities within and outside the atmosphere;

Men and women who work as scientists and use sounding rockets, satellites, or space probes in their research "expand human knowledge of the atmosphere and space" and are called space scientists. Their work is known as space science. Here, the Act was very clear; not only was the pursuit of space science an objective of NASA, but NASA was legally obligated to preserve the United States as a leader in that field.

Pursuing space science, however, was not the only objective of NASA. The third objective was [55]

> The development and operation of vehicles capable of carrying instruments, equipment, supplies and living organisms through space.

This objective, together with a decision by President Eisenhower on August 18, 1958, to assign the responsibility for manned space flight to NASA, put the new agency into the glamorous, highly visible and highly competitive realm of manned space flight.[56]

Manned space flight was not space science, although the media sometimes confused the two. The objective of manned space flight was to fly humans into space and recover them—not to expand human knowledge of phenomena in space. Space science (and life science) must compete with manned space flight for resources and for the attention of NASA management. Cool, abstract studies in space science could not generate the same kind of public excitement as the death-defying flight of an astronaut into space. Neither could manned flight eradicate the idea that its sole purpose was to excite the public and generate work for aerospace companies. Yet the Space Act mandated both functions and Congress expected NASA to lead the world in both.

Section 203, "Functions of the Administration," is the final section in the Act of significance to the selection and role of space scientists. It specifies three functions for the Administration of the new agency:[57]

(1) plan, direct, and conduct aeronautical and space activities;
(2) arrange for participation by the scientific community in planning scientific measurements and observations to be made through use of aeronautical and space vehicles, and conduct or arrange for the conduct of such measurements and observations; and
(3) provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof.

The first function placed the administrator of NASA in charge of all NASA activities. The second function, which concerned space science, was deliberately ambiguous. It left the administrator of NASA free to decide how to conduct the space science program. The administrator could, if he or she chose, conduct it entirely in NASA laboratories with government scientists. The NACA had successfully operated this way for 40 years; and many former NACA people thought NASA should operate in this same way. Alternatively, the administrator could operate the NASA space science program as the Vanguard program had operated. He or she could turn to academic scientists, delegate the planning of the program and the selection of the scientists to the National Academy of Sciences, and transfer funds to the National Science Foundation to purchase the scientific instruments. The other option, and the one that all NASA administrators have chosen, was to open the space science program to all scientists, whether located at universities or in government or industrial laboratories, and let them compete for the right to place their instruments on NASA spacecraft. As long as the administrator arranged to let the scientific community participate in the planning of the space science program, and widely disseminated the results, the Act left that person free to choose how he or she wanted to operate. Any provision for formal advisory boards or committees such as those of the NACA, NSF, or the Atomic Energy Commission, were conspicuously absent from the Space Act.

Just as the ambiguity in the Act left the administrator free to choose his or her course, it left other partisan groups free to pursue theirs. Even before the President signed the Space Act, the National Academy of Sciences created a Space Science Board and it immediately began to operate as the old Technical Panel for the Earth Satellite Program (TPESP) had operated in the Vanguard Program. The Board began preparing a national space science program and selecting scientists to conduct it.

Under the Act, only the administrator of NASA had the authority and responsibility to decide how NASA would conduct the space program.

From March 5, 1958, when President Eisenhower submitted the legislation that designated the NACA as the nucleus of the new space agency, through August 8, 1958, when he appointed the first NASA administrator, Dr. Hugh F. Dryden, the director of the NACA, acted as the administrator of, and directed the planning for NASA.

From March through April most people in Washington, including Dryden himself, expected the President to name him administrator of NASA. This was not to be. On April 16, while testifying before the House Select Committee, Dryden denigrated manned space flight and the race with the Soviets, thereby alienating powerful members of the Committee. A week later, Dryden returned to testify before the Committee where he was given an opportunity to modify his original position. He did not, at least not to the Committee's satisfaction. The members of the Committee informed the White House that they opposed Dryden's appointment as administrator.[58]

It is clear from the actions Dryden took, and the decisions that he made, that he intended to depend heavily upon the National Academy of Sciences, and its Space Science Board, and the National Science Foundation for help in NASA's space science program. In March, immediately after the President's decision, Dryden began to transform the NACA into NASA. He brought a propulsion engineer into Washington to lead a team of young aerospace engineers in the planning of the space flight program. Dryden placed no scientists on this planning team. By mid-July the team had planned and budgeted for sixteen scientific satellites, four lunar probes, three communication satellites, and four manned space capsules.

Although the members of this team did not include any scientists, it is clear that they were planning for a major space science program.[59] As discussed in the next chapter, Dryden helped create the Space Science Board and attended its first two meetings. He expected the Space Science Board to help plan the space science program, and, at least initially, to solicit and evaluate scientific proposals.

Chapter 3

THE SPACE SCIENCE BOARD

Formation of the Board

Space science was a hot topic in Washington in the spring of 1958. Scientists, busy trying to understand the origin and implications of the Van Allen belts, prepared experiments to study the effect the explosion of an atomic bomb in space would have on the magnetosphere and prepared instruments for the Pioneer missions to the Moon. It became a good deal hotter on June 2, when (as discussed in chapter 2) John W. McCormack, chairman of the House Select Committee on Astronautics and Space Exploration, introduced the Space Act of 1958. Not only did the House overwhelmingly approve the Act, but during the debate Leslie C. Arends, Republican Whip and a member of the same Select Committee, argued for a budget of $500 million to launch the new space agency and $1 billion a year thereafter.[60] In 1958, $1 billion was a lot of money and a good deal of it could go for space science.

Dr. Detlev W. Bronk, president of the National Academy of Sciences, must have had mixed feelings about the Space Act. It created a new agency, NASA, and made space science one of its major objectives. Bronk should have felt good about that. The Act, however, did not provide for any kind of scientific group to advise the NASA administrator or to oversee NASA's space science program, such as the National Science Board that guided the work of the National Science Foundation. The Act abolished the existing National Advisory Committee that had managed NASA's predecessor, the NACA. And it gave the NASA administrator complete control over NASA's space science program. Bronk would have been concerned about that, particularly since his friend, Dr. Hugh L. Dryden, the director of the NACA, was not likely to become the administrator of the new agency.

If Dryden were eliminated as administrator and the President appointed an administrator who would emphasize manned space flight, how could the Academy be sure that NASA would provide adequate funds for or give sound direction to its space science program? Bronk also had another, more practical and very pressing, concern. A week earlier, he had been informed that the IGY satellite budget was down to its last $4000. Academic scientists needed additional funds immediately, otherwise they must stop preparing their instruments for the Pioneer missions. Dryden and Dr. Alan T. Waterman, director of the National Science Foundation, were also concerned about continuing the space science program that had been started during the IGY.[61,62]

Two days later, on June 4, Bronk invited Dryden, Waterman, Dr. Herbert F. York,* and Lloyd V. Berkner ** to his office to help create the Space Science Board.[63] Dryden, Waterman, and York served as senior officials in the three agencies involved in space research. Berkner, creator and organizer of the IGY, president of the International Council of Scientific Unions, was deeply concerned about the competitive position of the United States in space science, not to mention the shortage of first-class space scientists, and was interested in the institutional and international aspects of science. He was a logical person to get things moving.

Gathered around a large conference table in their shirt sleeves with a portable blackboard to write on, these five people organized the Space Science Board. They designated Berkner chairman and Dr. Hugh Odishaw executive director and selected ten of the sixteen members of the Board. They divided space science into seven scientific disciplines, assigned the Board five tasks, and outlined a protocol to help the Board accomplish them.

The group seated around the table wanted the Board to attract some of the nation's best scientists into space science. It expected those scientists to prepare research proposals that the Board could evaluate. The group expected all three agencies, NASA, the National Science Foundation and the Department of Defense to continue to be involved in space science. The Board would coordinate the work of the three agencies, just as the Technical Panel had coordinated the work of several government agencies during the IGY. What the members did not anticipate was that NASA would create a strong technical group in Washington to manage all civil space science activity.

---

* Chief scientist of the Advanced Research Projects Agency (ARPA), the agency responsible for all U.S. space projects until NASA could take over the civilian projects.

** President, Associated Universities, Inc.

Later that same day Bronk sent telegrams to the people they had selected and invited them to serve on the Board. This day's work demonstrated the intense attention space science commanded in Washington in the spring of 1958.

On June 26, 1958, Bronk wrote to Berkner to give the Board its charter. He charged the Board to "give the fullest possible attention to every aspect of space science, including both the physical and life sciences." Bronk's letter made it clear that the Board was to work with the three agencies NASA, NSF, and ARPA, but as an advisory body, not an operating agency. Unlike the Technical Panel, the Board was not to conduct any space science program or formulate budgets.[64]

The First Meeting of the Board

Berkner called the fifteen members of the Board together for their first meeting in New York on Saturday, June 27, 1958. He probably picked Saturday as the only day he could gather the Board on such short notice. Berkner assembled a distinguished group of senior scientists. Twelve were from academia, ten were members of the National Academy of Sciences, and one, Dr. Harold C. Urey, was a Nobel Laureate. None came from military laboratories. Only two, Dr. James A. Van Allen and Dr. Richard W. Porter, were members of the Rocket and Satellite Research Panel and the Academy's Technical Panel for the Earth Satellite Program. Dr. Hugh F. Dryden, the only person present associated with the NACA and the only one who would be associated with NASA when it came into existence, attended as an invited participant, not as a member. Four members, Dr. Leo Goldberg, Dr. Bruno B. Rossi, Dr. John A. Simpson, and Dr. James A. Van Allen, were already engaged in space research.[65] Thus, space science moved away from the military laboratories and toward the universities and civilian government laboratories. It was also moving from the care of the self-constituted Rocket and Satellite Research Panel and the United States National Committee for the IGY (USNC–IGY) into an uncharted domain controlled by the Space Science Board and NASA.

Berkner's "4th of July Telegram"

Worried about the competitive position of the United States in space exploration, Berkner wanted to encourage the most highly qualified scientists in the country to become immediately involved in space research. There was no hesitation about soliciting proposals. During its first meeting, the Board decided to send telegrams to scientists all over the United States that requested them to send research proposals within a week. The Board sent over 150 copies of Berkner's "4th-of-July telegram," so-called because it reached many scientists on July 4, 1958. More than 200 scientists responded.[66]

Berkner's telegram had an immediate impact on scientists. As Dr. Kinsey Anderson, then a young scientist just starting his professional career, recalls: "It came as a bolt out of the blue, to this young scientist. I have a vivid memory of it—someone actually asking me to do science in space." He accepted the invitation and more than thirty years later he is still an active space scientist.[67]

The Board Selects Its First Space Scientists

Berkner asked Porter to review those proposals that required satellites or space probes and Van Allen to review those that required sounding rockets. Each was to come to the next meeting of the Board with a list of proposals worthy of support. Berkner also asked them to come with plans for research programs for the next two years.

Berkner's telegram eliminated most of the confusion in the process for selecting space scientists and opened space science to all scientists, not only to those involved with the Rocket and Satellite Research Panel or the USNC–IGY. The telegram outlined opportunities for space research, invited proposals, imposed a deadline for the response, and stated that the Board would evaluate the proposals and set priorities. The invitation gave every American scientist an opportunity to participate in the nations's space science program. In the jargon of today's space scientist, it was the first "AFO" (Announcement of Flight Opportunities) of the space science program. It was several years, however, before NASA began to issue its own AFOs.

Early Board Recommendations

On July 19, 1958, during its second meeting, the Board approved the recommendation of Porter and Van Allen. On July 24, Dr. Hugh Odishaw, executive secretary of the Board, wrote identical letters to Dryden, York, and Waterman.[68] Odishaw urged immediate support for the development of six experiments: a proton-precession magnetometer to measure weak interplanetary magnetic fields; an atomic clock to measure the change in frequency of the clock caused by the smaller gravitational field at the orbit of the satellite; a flashing light to be carried on a satellite and tracked by ground-based telescopes to determine the orbit of the satellite and measure the relativistic precession of the perihelion of the orbit; a bolometer to measure, from orbit, the energy radiated by the Earth; a combined Geiger counter and scintillation detector to study auroral radiation; and an inflatable sphere to measure the atmospheric drag on the satellite and determine the geoid of the Earth.

Odishaw's letter did not specify either institutions or scientists to conduct these experiments. Odishaw enclosed a letter from Porter that specified institutions but not scientists. For example, Porter's letter recommended "NRL and Varian" for the magnetometer experiment, NRL as the institution where scientists would analyze and publish the results of the experiment, and Varian as the industrial contractor where engineers would build the instrument. Earlier, the Working Group on Internal Instrumentation, the Academy group that evaluated the experiments for the Vanguard satellites, used the scientific competence of the scientist as one of the criteria for evaluating experiments and specified the scientist responsible for each experiment.

Porter's letter also recommended a short-range program consisting of thirty experiments that he believed could be ready for flight between 1958 and 1960. He was somewhat optimistic. It took NASA ten years to complete his "short-range" program.

In less than a month, between June 27 and July 24, Berkner organized the Board, solicited and evaluated proposals, and recommended roughly a decade of work for the yet-to-be-formally-created Space Agency. In his letter, Porter regretted "the haste with which this report was prepared; . . . it is particularly important to remember that this information is suitable for budgetary purposes only, and should not under any circumstances be used as a final definitized program." He recommended that "the Board assign to appropriate committees the job of writing a better description of each desired experiment and then request all potentially interested agencies to prepare firm proposals."[69]

The Committees of the Board

Berkner accepted Porter's recommendation that committees of the Board examine the proposals in greater detail, and on August 12, he established twelve committees, each chaired by a member of the Board. Seven of the committees consisted of scientists from the same or similar scientific disciplines. These discipline committees were expected to review proposals for experiments in their discipline and to recommend a scientific program. The work of the Optical and Radio Astronomy Committee and the Physics of Fields and Particles in Space Committee are typical of the work of the committees of the Board. Each contributed to the nation's space science program. Each influenced NASA's process for selecting space scientists. Their activities are also of interest because of a major difference in the background of their members. Three members of the Fields and Particles Committee were preparing experiments to fly on satellites, whereas none of the members of the Astronomy Committee had any experience with rockets or satellites. In addition to evaluating research proposals, the Fields and Particles Committee recommended policies and procedures for the administration of the space science program. The Astronomy Committee spent its time evaluating proposals and preparing a program.

Physics of Fields and Particles in Space

Berkner designated a chairman, Dr. John A. Simpson, and a co-chairman, Dr. James A. Van Allen, to head the Physics of Fields and Particles in Space Committee. For all other committees he designated only a chairman. Undoubtedly, Berkner knew that Simpson and Van Allen were working against tight deadlines to get their instruments ready for the Pioneer missions scheduled for later in 1958 and this was his method of ensuring that one or the other would be available to represent the Committee. Because it was the eighth committee on the list, Simpson's committee became known as "Committee 8" and is often referred to by this title in the files of the Space Science Board.

Immediately after the first meeting of the Board, and before his committee was established, Simpson contacted other scientists in the field. By July 10, 1958, he had assembled a list of experiments, descriptions of their scientific importance, and names of organizations that might conduct them.[70]

On October 14, 1958, Simpson convened the six-man Fields and Particles group at the University of Chicago.[71] He defined the task of the Committee as follows: [72]

> . . . . because the government agencies are not yet prepared to evaluate basic research proposals in this field, we have been asked to evaluate the first group of proposals which have been presented to these agencies for our critical comment. We are further asked to indicate where support should be given, both with respect to the kinds of experiments and the groups which could most likely carry out the tasks.

According to the minutes, the members of Simpson's committee first made a list of the kind of experiments they thought were important to do. This list did not contain names of scientists or institutions. They next evaluated the twenty-five specific proposals that the Board had assigned to Simpson's committee. Of these, fourteen were endorsed as worthy of support. Simpson's committee was very precise about the proposals it recommended for support. It named the investigator and described the objectives of the experiment. In some cases it approved only a portion of the objectives of an experiment.

After evaluating the twenty-five proposals, the Committee then went back to its list of experiments that should be done and found no proposals for three kinds of experiments. Nobody had proposed studying gamma rays, plasmas, or the aurora. The Board, said the Committee, should invite Dr. Herbert Friedman of the Naval Research

Laboratory to propose gamma-ray experiments and the Naval Research Laboratory and the Air Force Geophysical Research Directorate to propose plasma experiments. The Committee did not recommend taking action to generate aurora experiments.

The Committee endorsed theoretical research, improved telemetry, polar orbiting satellites, and the use of rockets with recoverable nose cones to carry film (nuclear emulsions) into and back from the magnetosphere.

On October 24, Simpson's committee submitted to the Space Science Board an Interim Report that summarized its recommendations. An examination of Section II, "Long Range Plans," provides some insight into the scientific thinking and the aspirations of the members of Simpson's committee. They proposed a lunar satellite and a station on the Moon for the study of particles and fields; a solar probe to pass inside the orbit of Mercury to study the particles and fields in the vicinity of the Sun; probes to the planets to study their magnetospheres; two kinds of Earth satellites, one in a highly eccentric orbit ranging from a perigee of a few hundred kilometers out to an apogee of a 100,000 kilometers and the other in a geostationary orbit. Both Earth satellites would be used to study the particles and fields in the Earth's magnetosphere as well as in interplanetary space outside the magnetosphere. In addition, the Committee endorsed plans to detonate atomic bombs in space to study their effects on the magnetosphere of the Earth.

Simpson's committee examined how one designed, built, and integrated a scientific instrument into a spacecraft. At the time of the meeting, two members of the Committee, Simpson and Winckler, had just completed preparing instruments for flight on a Pioneer spacecraft. The mission was under the management of the Air Force's Space Technology Laboratories (STL) and scheduled for launch in November 1958. They had encountered problems with the STL engineers over the design, testing, and integration of their experiments. They wanted to make sure that NASA, when it came into being, handled scientific experiments better than STL.

The Committee's report described five phases for a space science experiment: feasibility study, bench model, flight prototype, checkout and launch, and data reduction and analysis. The report did not explicitly specify who should be in charge of each phase; it read: "The above categories should lead to a clear definition of the responsibilities of the scientific investigator undertaking instrumentation design." It specified the obligations that the government agencies should undertake if they expected university scientists to participate enthusiastically in the program. These obligations included development of a launch vehicle and sufficient backup vehicles to ensure flight of the experiment; provision of a proper network of tracking stations; computer support; priority in the aerospace industry to acquire the components required to build an experiment; and the availability of a well informed and trained person to provide liaison between the experimenter and the group that integrated the experimenter's instrument into the spacecraft.

In the first report of Simpson's committee October 1958, are several of the policies and procedures that NASA later used to select space scientists and to define their role during a scientific mission. Some of these policies originated in the Committee; some, such as the importance of scientists' control over their instruments, were only restatements of policies developed by the institutions that had been flying sounding rockets and balloons for the past decade.

The Committee recognized the problems inherent in using satellites for research and began the process of finding solutions. The Committee assumed that most of the research would be conducted in universities. It assumed that NASA engineers would provide technical support to university scientists. At the time of this first meeting of the Committee, NASA did not yet have a space science organization or any space scientists. Later, the "well informed and trained person[s] to provide liaison between the experimenter and the group preparing the final package," which Simpson's committee wanted, turned out to be space scientists at NASA centers. These people were in direct competition with the members of the Committee for use of NASA's scientific satellites. These NASA space scientists also began soliciting proposals, selecting space scientists, and managing scientific missions—a situation that the members of the Committee had not foreseen and that led to much controversy between the Space Science Board and NASA during the next two years.

Simpson's committee did not, at least in the minutes of their meeting and their subsequent October 24, 1958, report, discuss the criteria or procedures they used to evaluate proposals and assign priorities. Following the tradition established by the Upper Atmosphere Rocket Research Panel and the Working Group on Internal Instrumentation, the Committee members evaluated their own and their competitors' proposals. They recommended for flight proposals by three members: Simpson, Van Allen, and Winckler. There is no question that in making these selections the Committee chose experiments proposed by competent scientists. Unfortunately, the procedure raised questions in the minds of scientists who were not members of the Committee and whose experiments were not chosen. They were not sure such a process could be fair. In the summer of 1958, when there were not many scientists competing, this issue was not so serious, but a year later as the competition became intense, it became a major issue in the NASA selection process. NASA initially allowed some space scientists at its centers to evaluate and select their own proposals. This practice, however, was soon eliminated with the emergence of strong scientific leadership at NASA Headquarters.

Committee on Optical and Radio Astronomy

Dr. Leo Goldberg, chairman of the Optical and Radio Astronomy Committee, stated that the function of the Committee was [73]

> . . . . to encourage the participation of as many astronomers as possible in the new field of space science and to provide guidance to them in the formulation and execution of their research programs and to provide advice, guidance, and assistance to all government space agencies to aid in the development of effective space science programs and experiments in the area of astronomy.

On October 6, 1958, he convened seven of the eight members of the astronomy group at Inglis House, Ann Arbor, Michigan. Before them to consider were the twenty proposals in physics, relativity, and optical and radio astronomy that the Board had assigned to the Committee. Unlike the Physics of Fields and Particles Committee, the Astronomy Committee did not create its own list of important experiments. Instead, its its members took the existing proposals and divided them into two categories: those whose instruments should be prepared for flight and those whose instruments needed more work before they would be ready for flight.

Midway through their work, Dr. Martin Schwarzschild became concerned about a proposal from a large organization "which does not contain a commitment stating which person will be the principal investigator and the amount of time he will devote to the project." The Committee paused, considered the situation, and then developed a set criteria to evaluate proposals: [74]

- Are the scientific objectives specifically defined?
- What is the competence of the investigators and to what extent are they committed to the project?
- Is this proposal best done by a satellite or probe, or can it be done as well by some other method (e.g., balloons or high-flying airplanes)?
- How has the investigator treated the technical details?
- Is the proposal within the present, or near future, state of the art?

From this discussion comes the concept of a "principal investigator": that scientist in charge of a space science experiment, committed to the experiment from the time he, or she, conceives it until he, or she, has published the final results. In this concept, the principal investigator designs, builds, tests, and delivers the flight instrument to NASA. That scientist is part of the team that integrates the flight instrument into the spacecraft and makes sure that it will operate in space as planned.

After considerable debate between the Jet Propulsion Laboratory and NASA Headquarters, NASA adopted this definition of the role of the principal investigator. JPL's management argued that the Laboratory had to build and test the flight instruments in order to ensure the integrity of the instrument and the planetary spacecraft. The converse of this issue developed between NASA Headquarters and some academic scientists who were accustomed to purchasing their instruments from commercial firms. These scientists wanted NASA to build or purchase instruments to their specifications, operate them, and then send the data to the scientist for analysis. NASA rejected these requests and insisted that a scientist—the principal investigator—be in charge of each experiment. This principal investigator was expected to understand the objectives of the experiment and all the quirks and limitations of the instrument and be prepared to stake his or her scientific reputation on the results of the experiment.

The Astronomy Committee reviewed its twenty proposals. It recommended flight for some and rejected others for technical reasons (one otherwise excellent proposal ivolved the use of radio signals from a lunar probe to measure electron density but neglected to consider the effect of the radio-noise background). The Committee considered and rejected a proposal to explode an atom bomb in space to measure more accurately the velocity of light. It decided such an explosion would needlessly contaminate interplanetary space and that the experiment could be conducted as well on the ground by using eclipsing binaries.*

Leo Goldberg focused his committee's work on basic scientific questions. The first experiments the Committee evaluated were those designed to test the theory of general relativity. The Committee worked on scientific issues and did not consider broad policy or management problems.

Goldberg's committee also succeeded in its primary goal of stimulating interest in space astronomy. In 1957, only three institutions conducted experiments in space astronomy: the Naval Research Laboratory, the University of Colorado, and the Air Force Cambridge Research Laboratories. When the Committee completed its work two years later, Dr. Arthur Code, from the University of Wisconsin, and Dr. Fred Whipple, from the Smithsonian Astrophysical Observatory, were preparing experiments for

* A pair of stars orbiting around their common center of mass.

the Orbiting Astronomical Observatory. In addition, groups at the University of New Mexico, University of California at Berkeley, University of Michigan, Princeton, Yale, and the California Institute of Technology had begun research in space astronomy.

The other five discipline committees also met in October 1958, considered the proposals in their areas, and sent recommendations to the Space Science Board in time for its third meeting on October 24, 1958. At this meeting the Board reviewed and approved the recommendations and sent them to NASA on November 4, 1958.[75]

The Board's Impact on NASA's Selection Process

On October 24, 1958, the Board met for the third time in New York City, where it reviewed the recommendations of its committees and reconsidered its role in relation to a NASA that had formally opened its doors on October 1, 1958. At this meeting, the Board began its long, generally productive but frequently acrimonious, association with NASA. One of the principal NASA participants in this relationship, Dr. Homer E. Newell, characterized it as a "love-hate" relationship. The NASA that the Board began to work with on October 24 was not exactly the NASA envisioned by those who had created the Board back in June. This third meeting of the Board will be considered in detail below after the early NASA organization and its approach to space science has been examined.

The efforts of Lloyd Berkner and the members of the Space Science Board galvanized many young academic scientists into proposing experiments and becoming space scientists. Thus, academic scientists became major participants in the nation's space science program. The board helped NASA define the role and responsibility of a space scientist during a NASA space science mission. In the four months between its first meeting on June 27 and the time NASA opened its doors on October 1, 1958, the Board solicited and evaluated over 200 proposals and recommended to NASA those it thought worthy of flight. It outlined a space science program containing over thirty missions that would take NASA the better part of the next decade to accomplish. The Board continued the practice of using senior scientists to evaluate scientific proposals—and of allowing these scientists to evaluate their own and their competitors' proposals.

The Board generated a momentum and interest in space science among academic scientists that ensured strong academic participation in the NASA space science program. This participation of academic scientists would ensure a continuing source of young space scientists, new ideas, and rapid incorporation of the knowledge and technology developed in the program into the national technical capability. In addition, academic participation would provide an external group of scientists with a vested interest in funding for NASA's space science programs. In the future, when the United States had established its leadership in space science and the leaders of Congress were no longer interested in chairing the space committees and pressuring the Administration to catch up with the Soviets, these academic scientists could, and would, lobby the Congress for support of the NASA Space Science Program.

Chapter 4

NASA ORGANIZES

This chapter describes the change in plans for space science that took place in August 1958 when President Eisenhower appointed T. Keith Glennan as the first NASA administrator. It provides the background of the team Abe Silverstein assembled to manage NASA's space flight program.

A Change of Plans for Space Science

From March 5 through August 19, 1958, Dr. Hugh F. Dryden directed the plans to convert the NACA into NASA. He worked closely with the president of the National Academy of Sciences to create the Space Science Board and planned a NASA organization that would emphasize the importance of space science and be designed to work closely with the Board. Glennan changed that organization into one that reduced the emphasis on space science and focused on the massive engineering and management problems that faced the new agency.

Dryden's Plans for Space Science

It was true in 1958 as it is now that each government agency has an organization chart that reflects the way the head of the agency wants it to operate. Titles and proximity to the head indicate the importance of a particular program or function. Between May 20, 1958 and August 19, 1958, when the new administrator was sworn in, Dryden's staff prepared at least four versions of a NASA headquarters organization chart. They reflected Dryden's plans for space science. All four of the charts show an Office of Space Science headed by an associate administrator who reported directly to the administrator.

The August 11, 1958 organization chart, the last one prepared under Dryden's direction, shows the importance Dryden gave to space science and the role he expected the Space Science Board to play. The chart shows four associate administrators reporting directly to the Office of the Administrator. One of these is an associate administrator for Space Science who has four assistant administrators reporting to him: an astronomer, a physicist, a biologist and a meteorologist. The chart also shows a dotted box linked directly to the associate administrator for Space Science containing the long detailed title, "To Utilize the Services of the Scientific Community, e.g. the National Science Foundation, The National Academy of Sciences etc."

When this chart was prepared, the Space Science Board had met for the second time and its chairman, Lloyd V. Berkner, had sent Dryden the Board's first recommendation for six space experiments. The Board was preparing recommendations for additional space science experiments and Dryden was preparing an organization to receive and implement them. This coherence between the plans of the Board and the plans of NASA was to be expected. Dryden had helped to create the Board and attended its first two meetings.

On August 1, 1958, Dryden testified again before the House Select Committee on Astronautics and Space Exploration and further alienated the Committee when he stated that "the prospective space programs are not such as to leapfrog the Soviets immediately, or very soon." Those were not the words the Committee wanted to hear. They wanted an administrator who intended to develop a program that leapfrogged the Soviets and captured U.S. leadership in space exploration. Dryden did not sound like that kind of an administrator. From the written history, it is unclear whether Dryden was the first casualty in a long war over the importance of manned space flight or whether Eisenhower wanted a Republican businessman to head NASA rather than Dryden, "the good, grey, scientist" and nominal Democrat.[76,77]

Glennan's Plans for Space Science

In any case, on August 8, 1958, Eisenhower announced the nomination of T. Keith Glennan to be administrator of NASA. Glennan, former president of Case Institute of Technology and a former Atomic Energy commissioner, understood science and engineering, recognized the need to be competitive with the Soviets in space, and saw the importance of manned space flight in that competition.[78] Glennan requested Dryden's appointment as the deputy administrator of the new agency. Glennan knew and respected Dryden and wanted his technical competence and administrative ability in the new agency. The two were sworn in on August 19, 1958.

Glennan's concept of the importance of space science differed from Dryden's. On August 19, 1958, immediately after he was sworn in as NASA administrator, Glennan met with Dryden and his staff to discuss the NASA organization. Two days later, the staff issued another organizational chart. On that chart space science has disappeared. In its place there is a director of Space Flight Programs and under that an assistant director for Space Flight Research, but no mention of space science or a liaison with the space science community. On October 24, an assistant director for Space Science reporting to the director of Space Flight appeared on another interim organizational chart.[79,80] NASA formulated and began to conduct a space science program but it was done by scientists serving under former NACA aerospace engineers. A separate office of space science, reporting directly to the administrator did not reappear on a NASA organization chart until James E. Webb put it there on November 1, 1961.

NASA Opens Its Doors

On October 1, 1958, Dr. Glennan formally opened the doors of NASA in the old Dolley Madison House across Lafayette Square from the White House. The Administration and the Congress had created, on paper, a unique agency and given it the authority and responsibility that they thought it needed to catch up with the Soviets. It was now up to Glennan and Dryden to convert the NACA into NASA and recruit the additional people they needed to conduct the program.

Glennan selected as the director of the Office of Space Flight, Abe Silverstein, the propulsion engineer that Dryden had brought to Washington in March 1958 to lead the NACA planning team. For its next three formative years, Silverstein led the entire NASA space flight program.

Silverstein's Team

In December 1957, Abe Silverstein, associate director of the Lewis Flight Propulsion Laboratory, enthusiastically supported the NACA's bid for the space program. When he came to Washington in the spring of 1958, Silverstein was fifty years old, at the peak of his career, a hard-driving, decisive, and talented engineer, a perfectionist, and an excellent judge and developer of people. He soon assembled a young aggressive team of NACA engineers to help him plan and execute the space program. Many of the people in that team went on to become NASA center directors and presidents of aerospace companies and universities.[81,82,83]

Silverstein brought together the people, selected the launch vehicles and spacecraft, and made the early decisions that led to NASA's successful scientific missions during the 1960s. From October 1, 1958, through November 1, 1961, all space science missions and their payloads had to be approved by Silverstein.

In the fall of 1958, Abe Silverstein and his team of young research engineers spent long, but exciting, days in the Dolley Madison House.

They had to start a manned space flight program and find the facilities, launch vehicles, and spacecraft needed to fly the experiments recommended by Lloyd Berkner and the Space Science Board. They had to get new rockets and new spacecraft under development. They needed a staff for the new space flight center * in Beltsville, Maryland, and they were negotiating with the Army to transfer the Jet Propulsion Laboratory in Pasadena, California, to NASA. Although Silverstein had begun negotiations with Dr. Homer E. Newell to join NASA, Silverstein's team still did not contain any scientists when NASA opened its doors.

NASA Gets Its First Space Scientists

Busy as he was, Silverstein knew that he needed experienced space scientists on his team. He needed answers to such questions as: How do you formulate a scientific program and select the scientists to conduct the research? Can I package many experiments on one large spacecraft or must I furnish a specialized spacecraft for each discipline? How many commands are needed to control a scientific experiment? How much and what kind of data must be returned from a spacecraft? What kind of a tracking and data acquisition system will I need?

Neither he nor his staff knew the answers to these questions, yet he needed the answers before he could make decisions. He could go to the Space Science Board and its committees for help—he was a member of the Board's Committee on Future Development—but he needed the answers immediately; he could not wait for the passage of motions at the monthly meetings of the Board to get the information that he needed. He needed someone down the hall and in his Friday afternoon staff meetings who knew the answers or knew where to get them.

Sometime in late August, shortly after he was appointed director of the Space Flight Program, Silverstein discussed with Dr. Homer E. Newell the transfer of some scientists from the Naval Research Laboratory (NRL) to Silverstein's new Beltsville Space Flight Center. Newell had exactly the opposite of Silverstein's problem. He was in charge of a group of space scientists who were worried about their future now that space science was becoming a civilian, rather than a military activity.[84]

Later, not hearing further from Silverstein, Newell went to see him to find out what he planned to do about space science. Newell brought with him two colleagues from NRL, John W. Townsend, Jr., head of

* On August 1, 1958, even before Eisenhower had appointed an administrator of NASA, Senator J. Glenn Beall called a press conference and announced that NASA intended to build a new laboratory in Beltsville, Maryland.

the Rocket Sonde Branch, and Dr. John F. Clark, head of the Atmospheric Electricity Branch. Newell and his scientific colleagues offered their services to Silverstein because they believed in a civilian space program and because they wanted to help shape and participate in NASA's space science program. They also wanted access to NASA's launch vehicles, spacecraft, and the facilities of the new space flight center in Beltsville. They knew that NASA would control most, if not all, of the money allocated for scientific research in space and they were afraid that NASA might follow the NACA's pattern of conducting all space science with in-house scientists. If NASA followed this course, and the military dropped its support of space research, then the NRL scientists would be left without resources for their research programs.

Newell's discussions with Silverstein were not sanctioned by his superiors at NRL. Earlier, they had readily agreed to transfer to NASA the troublesome Vanguard Program and the NRL technical people associated with it. The management of NRL, however, opposed the transfer of NRL scientists to NASA.[85]

Newell's visit with Silverstein went well. Silverstein drove out to Newell's laboratory at NRL, liked what he saw, and decided that he could use a number of the NRL scientists. He invited Newell to become his assistant director for Space Science. Newell accepted, and along with Townsend and Clark, he officially joined Silverstein's staff at NASA Headquarters on October 20, 1958.

In spite of the opposition of the NRL management, about fifty NRL scientists and engineers decided to join NASA. On December 28, 1958, they were formally transferred from NRL to the new Beltsville Space Flight Center. While waiting for the construction of their new laboratory, these people moved into a refurbished warehouse on the grounds of the Naval Research Laboratory. Some of the senior people began spending much of their time at the Dolley Madison House helping Silverstein and Newell organize NASA and plan a space science program.

On October 24, 1958, NASA issued another interim organization chart that had names as well as functions on it. Silverstein is shown as the director of the Office of Space Flight Development, one of three offices that reported directly to Glennan. Newell is shown as the assistant director of the Office of Space Sciences. Under Newell are three chiefs of programs: Dr. John F. Clark for the Ionospheres, Morton Stoller* for Space Sciences, and John W. Townsend, Jr., for Space

* An ex-NACA engineer from the Langley Aeronautical Laboratory. In 1961, Stoller became the first director of NASA's Office of Applications.

Sciences. On this chart, there is no reference to any use of the services of the scientific community or even a liaison with the Space Science Board.

The team of NACA research engineers and NRL scientists that Silverstein assembled at the Dolley Madison House shared many traits. They were mostly between thirty-five and forty-five years old. Most had served in World War II as enlisted personnel or junior officers. Many went to school on the GI Bill. Both groups were civil service employees who conducted research in government laboratories, were good in their respective research areas, and were proud of their heritage. Both groups were young, aggressive, ambitious, committed to a civil space program, and driven to explore space and reclaim American leadership in space science and technology.

The similarities ended there. The natures of their research, professional culture, and the things they thought important were quite different, and these differences led to sharp clashes between the two groups over issues ranging from the objectives of space science missions to where to publish the results.

The NACA Heritage

John F. Victory's forty-three-year tenure (from the creation of the NACA in 1915 to the formation of NASA in 1958) was typical of NACA people. The NACA hired bright young engineers fresh out of college and trained them in its laboratories to do applied science and engineering research, and expected them to remain with the agency for the rest of their professional careers, which many did. A new young NACA engineer worked as an apprentice to a senior NACA research engineer who taught him how to conduct research on aircraft models in the NACA's wind tunnels and on rocket-propelled models in the atmosphere. After this early training, an NACA engineer conducted research to understand and to improve the behavior of man-made objects—airplanes and rockets—in flight through the atmosphere and space. These NASA engineers developed theories of flight, invented new airfoils or control systems, and continuously sought to make their machines fly higher, faster, farther, cheaper, fight better, and carry ever heavier payloads. They conducted their research in laboratories or used their own or DOD-furnished airplanes and rockets. They published their research results in the NACA's own journals, which were edited by senior NACA engineers and published at the Langley Laboratory. They worked closely with the aviation industry and the Air Force and Navy's flight programs.

As members of a government research organization, the NACA's research engineers were accustomed to working quietly out of the glare of publicity except for an occasional acknowledgment when someone with the "right stuff" set a new speed or altitude record in a machine designed according to NACA theories or tested by its engineers. Their rewards included the recognition of their contributions by their peers in the NACA and the aerospace industry and watching the results of their research become a part of a modern aircraft and rocket systems. Many aspired to become NACA center directors, a position generally considered the most rewarding and prestigious in the agency. Interested in practical results, they had little time for esoteric scientific research producing findings that might sit on a shelf for twenty years before somebody came up with a use for them.

Design engineers from aerospace companies and the Air Force and the Navy respected the work of the NACA laboratories, eagerly followed their research, and maintained libraries of the yellow NACA technical reports.

There were no "space science" committees among the NACA advisory committees. The NACA was not a scientific research organization, nor did the people in the NACA consider themselves scientists. However, some of the results of scientific research using rockets interested the NACA research engineers. They needed better information about the atmosphere to help predict the flying qualities of airplanes and rockets. Accordingly, they worked with the Upper Atmosphere Rocket Research Panel, using the Panel's sounding rocket data on the pressure, composition, temperature, and winds in the upper atmosphere, to create a "United States Standard Atmosphere." As professional NACA engineers, however, they were not interested in understanding why the atmosphere had these particular properties. Van Allen's results interested them because they sharply changed the radiation environment in space and showed that future spacecraft must be designed to operate in that environment. The origin, source of energy, or the lifetimes of the particles in the belts, however, were not of professional interest.

The NACA members of Silverstein's team were research engineers rather than scientists. They were proud of the NACA and proud of the work they did. They tended to look at the scientists as impractical dreamers, incapable of producing any hardware or knowledge of useful value.

The NRL Heritage

The scientists who came to NASA from NRL brought a different professional perspective. They came from a different professional culture and judged their own work according to criteria quite different from those used by the NACA engineers. Although they came from a military laboratory and worked in fields of long-term interest to the Navy, they conducted research to understand natural phenomena in the atmosphere and space. They sought to discover new phenomena and acquire a better understanding of, or a new insights into, existing phenomena. They flew instruments on balloons, sounding rockets, and satellites, publishing the results of their research in professional scientific journals, such as the *Physical Review* and the *Journal of Geophysical Research*. They aspired to membership in the National Academy of Sciences. With the goal of advancing human understanding of the physical world, they engaged in basic rather than applied science.

They also studied and developed rockets and spacecraft, not as intrinsically interesting objects in themselves, as did their counterparts from the NACA, but as vehicles to transport their instruments through the atmosphere to the ionosphere where they wanted to take measurements.

Most of these scientists came to NRL as trained researchers, after spending five to seven years in university laboratories doing research for their theses. Although the NRL scientists conducted their research in federal laboratories (as did the NACA research engineers), they maintained stronger ties with the academic community. The NRL scientists considered themselves as scientists doing basic research, not as applied scientists or engineers solving problems or improving machines. They too were proud of their heritage and tended to consider the engineers from the NACA as individuals who were not interested in or capable of understanding the challenge and importance of basic research.

The NACA engineers' understanding of, and proficiency with, machines in space enabled NASA to produce useful and highly reliable hardware for space science missions. Space scientists used that hardware to establish American leadership in space science. Although they sometimes squabbled over whether to measure the success of a mission in terms of the successful operation of a spacecraft or of the significance of the scientific results, they rapidly learned to respect one another's capabilities and working together the two groups became a formidable team.

A Love-Hate Relationship with the Space Science Board

On October 25, 1958, five days after he was sworn in as Silverstein's assistant director for the Office of Space Science, Dr. Homer E. Newell flew to New York to attend the third meeting of the Space Science Board. At that meeting, Newell began what he characterized in his book as a "love-hate relationship" with the Board.[86]

Unlike the first two meetings that Dryden had attended, this meeting began with no NASA representative present. At some point during the discussion, Dr. James A. Van Allen suggested, and the Board unanimously agreed, that the Board should have "formal NASA representation at a high level." Lloyd V. Berkner, chairman of the Board, called someone in NASA, presumably Dryden. As a result, Newell flew up from Washington to attend the remainder of the meeting.[87] Although he was unknown to most of the members of the Board, Newell was well known to four members. Most recently, he, Odishaw, and Van Allen had served together on the Technical Panel on the Earth Satellite Program, chaired by Dr. Richard W. Porter, and for the past decade Porter and Newell had served together on the Upper Atmosphere Rocket Research Panel, chaired by Van Allen.

Prior to the meeting, someone, probably Odishaw, in his role as executive director of the Board, drafted a document that described the roles that the Board expected the government agencies involved in space science to play in the nation's space science program.[88] This document proposed a major operational role for the Board, a role similar to that the Technical Panel for the Earth Satellite Program (TPESP) played in the Vanguard Program. According to this document, the Board would plan scientific missions and solicit and evaluate proposals for research on those missions; the National Science Foundation would pay for the instruments and the research of academic scientists; and NASA, or ARPA, would provide the rockets and spacecraft. NASA's centers were expected to furnish any engineering or operational support that university scientists might require.

During the meeting, Dr. O. G. Villard introduced this document and proposed that the Board approve it so that it could be published as a booklet. The official minutes report only that the Board did not approve the document and that Berkner requested time for the Board to review and comment on the final draft prior to publication. After the meeting, Newell returned to Washington and wrote a four-page "Memo to the File" that described the meeting in detail.[89] In his memo, Newell characterized this part of the meeting as a "lively" discussion of the Board's charter and purpose: [90]

> Porter strongly recommended that the Board be careful to act only in an advisory capacity, and be very careful to make plain it is not entering into or attempting to enter into the decision making that belong to NASA, NSF, and ARPA. Otherwise, those with vested interests sitting on the Board could be subject to severe and bitter criticism. Berkner agreed to the principle involved and stated by Porter, but felt that the Board must make recommendations. Porter cautioned that recommendations from the Board are in the nature of decisions by the Board, even though it is understood that future decisions must still be made by NASA, NSF, and ARPA.

Porter's remark about "those with vested interests sitting on the Board" is one of the first recorded acknowledgments of the conflict of interest that existed when scientists evaluated and established flight priorities for their own experiments. It may have reflected the growing concern among some young scientists that the only way to get an experiment flown in space was to get appointed to the group that selected experiments to fly.

Later in the meeting, the Board discussed whether or not it should recommend a specific package of instruments for a specific satellite or space probe or approve individual proposals for flight whenever the opportunity arose. According to the official minutes, Dr. Richard Porter, chairman of the Board's Committee on Immediate Problems, proposed that his committee be recast as a programming committee with Hornig, Villard, Van Allen, Newell, and Canright* as members. The Board unanimously approved Porter's suggestion. Newell's memo recorded the discussion as follows: [91]

> Porter stated that he felt that if the Board were going to make such recommendations that these recommendations should then be participated in by the Board itself, and not left up to its committees. He recommended further that the Board set up a group containing members of the Board, and members of ARPA and NASA, ex officio.

Finally, the Board discussed the supervision of contractors. The official minutes record: [92]

> The Board noted with alarm some discussions of the failures of some recent experiments because of inexperience and ineptness on the part of the prime contractor. It was agreed that the need for close supervision and a clear definition of responsibility in this sensitive area should be brought to the attention of NASA. Concern was also expressed for a clear definition of the prime authority of the scientific role in the conduct of experiment.

Newell's version of the same discussion identifies the prime contractor and the scientists: [93]

> During the discussion of the space probes, several members of the Board referred to STL's performance on the recent Pioneer operation as very poor. Hornig described the science work as shockingly careless in its approach. Van Allen was less severe in his criticism but concurred that the performance was poor—"greenhorn" as he called it. Simpson was strong in his feeling that the STL work on the science package was poor. Specific complaints were that the checkouts of equipment such as the ionization chamber were incomplete and inadequate; not enough care was given to calibrations; not enough care was given to total systems integration and testing.

Newell's memo implies that he was a passive observer at this meeting, but he was not permitted to remain so passive. Before

---

* Mr. R. B. Canright, ARPA representative at the meeting.

another year was out, the Board criticized NASA's handling of space science missions in equally blunt terms, and Newell struggled to solve the problem.

NASA Plans Its Own Space Science Program

After listening to the members of the Space Science Board discuss the role some of them planned for NASA's new Beltsville Space Flight Center, Newell spent October 29, 1958, in a meeting with his boss, Abe Silverstein, John W. Townsend, Jr., and Dr. John P. Hagen, discussing NASA's plans for that same Center. Hagen headed the Center's Vanguard Division, which had been transferred en masse to NASA on October 1, 1958. Townsend was organizing the fifty NRL scientists who were to transfer to the Space Flight Center into a newly created Space Science Division. At issue was the role of these two divisions in payload systems work.

Two things were settled at the meeting. The Space Science Division would conduct a broad program of basic research in the space sciences and would "prepare scientific experiments and *payload systems* for sounding rockets, and scientific experiments for earth satellites and space probes." The Vanguard Division would undertake the "responsibility for the integration of scientific experiments from the Space Science Division *as well as from outside groups* into payload systems for satellites and space probes."[94]

These were two significant decisions. The Center's engineers would integrate experiments prepared by university scientists into NASA's spacecraft. The Space Science Board and academic scientists would be happy; they wanted NASA to provide that kind of support. The NRL scientists transferring to the Center would conduct their own experiments on NASA spacecraft. The Board and academic scientists would not like that decision; it placed the Center's space scientists in direct competition with university scientists for the limited space on NASA's spacecraft. Several years' experience and considerable acrimonious debate were required before the Board and academic scientists would understand the value of having space scientists at the NASA centers to help plan missions and design spacecraft. At this meeting, NASA took its first step to help academic scientists participate in a broad-based national space science program.

On November 25, 1958, NASA took another major step. Newell asked Dr. John F. Clark to draft a "Proposed NASA Policy and Procedures on Space Flight Experiments." Silverstein sent a slightly revised version of the policy to Glennan, who approved it on December 15, 1958. This policy firmly started NASA on the road toward a broad-based space science program, but a program that would be planned and executed by NASA, not by the Space Science Board.

According to this policy, NASA would formulate a national program of space research "from recommendations of the National Academy of Science's Space Science Board, from proposals and suggestions of educational and research institutions, industry, and other contractors and from internally generated ideas." NASA would conduct the program "on the broadest possible base by enlisting and supporting the participation of educational and research institutions, industry, and government activities, along with an adequate internal effort." And "NASA will establish relative priorities for experiments and projects, and will fix schedules, taking into account recommendations of the Space Science Board and the scientific and industrial community, with due heed to the engineering, logistic, operational, and budgetary factors involved." [95,96]

In short, NASA planned to use the proposals and recommendations of other institutions and its own space scientists, as well as those of the Space Science Board, to formulate a broad-based space science program. NASA, not the Board, would decide the priorities, set the schedules, and select the scientists.

The policy also created the all-powerful NASA project manager. It states that "a member of the NASA staff will be assigned as project manager for each flight program. He will represent NASA and be generally responsible for the overall coordination of the activities of the various participants. . . . and will have responsibility and authority for resolution of any disagreements between and among various participants."

The policy specified that NASA would assign responsibility for each phase of a mission and that experimenters would provide the research instruments to be integrated into the payload. It also described how NASA planned to distribute the data from a scientific mission: the "required distribution of raw data to program participants will be controlled by the NASA project manager. In general each investigator will receive the raw data from his experiment, and such other data as are needed to complete the interpretation of his results. After NASA approval, publication of scientific results in NASA publications or in the open scientific literature will be in accordance with accepted scientific practice." [97]

This two-page policy, approved by Glennan in December 1958, outlined the essence of the NASA policy for the planning and execution of space science missions. This statement of policy is silent as to how NASA planned to evaluate proposals and to establish priorities for experiments. Scientists at universities and NASA centers took exception to the idea that they could not publish their scientific results until after approval by NASA Headquarters. Buried under a blizzard of scientific papers requiring approval. NASA Headquarters soon delegated the approval of scientific papers to the principal investigators themselves. It took NASA another year of internal wrangling to turn this broad policy into specific procedures and another two years before the policy and procedures would be understood and accepted by space scientists.

On December 23, 1958, after issuing this policy, Glennan sent a carefully worded letter to Dr. Hugh Odishaw, executive director of the Space Science board, thanked him for the Board's help, to date, and stated that "we are in the process of making final decisions on the experiments to be made in the near future. When we have formulated our program I think it would be desirable for Dr. Dryden and Dr. Newell to meet with the Board to discuss the program which has then been approved." [98] As far as NASA was concerned, the Board's short-lived effort to formulate and control the national space science program, as it had for Vanguard, was over. NASA would consider the Board's recommendations along with any others that it received, and NASA Headquarters would make the decisions. The Board, however, largely ignored Glennan's letter and continued with its self-assigned tasks for another year.

This policy left Newell with two nagging problems: who in NASA was to make the decisions, and who was to help Newell and his three-man staff evaluate all the proposals and assign them their proper priorities? In December 1958, Silverstein exacerbated Newell's manpower problems. He appointed John W. Townsend, Jr., one of Newell's three staff members, as director of the Space Science Division at the Beltsville Center. This left Newell with only one space scientist, Clark, and one ex-NACA engineer, Morton J. Stoller, to plan and execute the space science program.

JPL Transferred to NASA

Newell's job became even more complex at the end of the year. In addition to working with the Space Science Board, academic scientists, and his former NRL colleagues at the new space flight center, he found that he had to conduct a major portion of the space science program at another laboratory that was directed by an old colleague from the Upper Atmosphere Rocket Research Panel, Dr. William H. Pickering, who had his own strong ideas as to who should plan the space science program and select space scientists.

On December 3, 1958, the Army transferred the Jet Propulsion Laboratory * to NASA. The California Institute of Technology had

* A government-owned laboratory in Pasadena, California, staffed and operated by the California Institute of Technology.

established the Jet Propulsion Laboratory in 1944 to conduct rocket research. Except for a brief period during 1945 and 1946 when the Laboratory conducted studies of hydrogen-oxygen propulsion systems for the Navy Bureau of Aeronautics, JPL had developed and tested missiles for the Army. In October 1957, after Eisenhower gave the go-ahead to the Army to launch a satellite, Pickering campaigned for, and received, the assignment to build the satellite. This assignment gave JPL much favorable publicity and led Pickering, and Dr. Lee DuBridge,* to lobby in Congress in late 1957 and early 1958 to have JPL designated as the Nation's space laboratory.[99] They failed, and late in 1958 found themselves working for Abe Silverstein. By mutual agreement with Pickering, Silverstein assigned to the Laboratory the responsibility to plan and execute lunar and planetary missions, as well as to develop the rocket upper stages that were needed to launch spacecraft to the Moon and the planets.

JPL was a propulsion laboratory and, although operated by the California Institute of Technology, it had not engaged in scientific research. Like the NACA laboratories, JPL conducted its propulsion research and development in its own laboratories. The staff of JPL was accustomed to a great deal of independence in its work for the Army and deeply resented the strong technical direction that began to come from Silverstein and his staff.

NASA's First Official Organization

The transfer of JPL at the end of 1958 completed the initial buildup of NASA. Starting on October 1, 1958, with the original NACA organization, the Vanguard Project, and the ARPA Pioneer and Explorer Programs, NASA had acquired the NRL scientists and JPL and created the Beltsville Space Flight Center. The NASA organization was complete. Although NASA needed many additional people, it planned no more mass transfers of personnel or laboratories.

On January 27, 1959, Glennan approved the first official NASA organization chart, which was quite similar to the tentative chart issued on October 24, 1958.[100] Three levels of activity were listed on the chart: at the top was "Executive Direction," which consisted of the Office of the Administrator, the deputy administrator, an associate administrator, and their staffs. The next level was "Programming Operations," which consisted of three major offices: the Office of Business Administration, the Office of Aeronautical and Space Research, and the Office of Space Flight Development. The third level, labeled "Field Activities," broke NASA field centers into two kinds:

* President of the California Institute of Technology and Pickering's immediate supervisor.

research centers—the old NACA laboratories, reporting to the Office of Aeronautical and Space Research, and space project centers, reporting to the Office of Space Flight Development. There were two space flight project centers: the Beltsville Space Flight Center and the Jet Propulsion Laboratory.

Silverstein's team was complete. It included engineers, scientists, managers, and accountants at Headquarters to handle programming operations and the two field centers to execute the flight projects.

Early Launch Failures

NASA did not do much in 1958 to leapfrog the Soviets. Four launch attempts failed: three Pioneer space probes and one satellite. Pioneer I, prepared by Space Technology Laboratories for ARPA, and taken over by NASA on October 1, 1958, was launched October 11, 1958. It reached 114,000 kilometers and provided information on the extent of the radiation belts, but failed to reach the Moon and thus was counted as a failure by the media. NASA launched Pioneer II, also prepared by STL, a month later. It reached only about 1500 kilometers because of the failure of the third stage. Pioneer II provided some limited scientific data. Dr. John A. Simpson, for instance, showed that there were more than 75 MEV (million electron volt) protons in the inner radiation belt.[101] Pioneer III, prepared by the Von Braun group, was launched on December 6, 1958, and also failed to reach the Moon.

Scientists, NASA, and the public looked to 1959 to be a better year and to provide another chance to overtake the Soviets. Unfortunately, 1959 brought more trouble for Newell and his beleaguered staff and more humiliation for Americans.

Chapter 5

1959: A YEAR OF TROUBLE AND CONFLICT

Newell's Hybrid Space Science Organization

By January 1959, Dr. Homer E. Newell already had his hands full. He had to plan a national space science program even as he worked to organize the scientists from academia and NASA into a coherent force to carry out the program. To help him with this formidable task, he had only two people on his staff at NASA Headquarters. Although Newell needed the help of scientists, scientists did not want to give up their research work to come to Headquarters to push paper, even for a program as exciting as space science.

Newell thought he had a solution. He would augment his staff with senior scientists from the Goddard Space Flight Center.* When they were needed, these Goddard scientists would work part time at Headquarters. If there was a proposal that needed reviewing or if the Bureau of the Budget or Congress requested a technical briefing, then a Goddard scientist could drive into Washington and do the work. These people could use the rest of their time to conduct their own research at the Center. Such an arrangement gave Newell access to the scientists he sorely needed and required a smaller number of scientists to give up their research careers to work full time at Headquarters.

Before the year was out, Newell encountered such serious problems with his hybrid organization that he was forced to eliminate it. In January 1959, however, he did not foresee what would happen and he proceeded with his plan. He turned to his old friend and former colleague from NRL, John W. Townsend, Jr., the newly appointed director of the Space Science Division at the Goddard Space Flight

* Although from its creation in 1958 through May 1960, it was the Beltsville Space Flight Center, hereafter it will be referred to as the Goddard Space Flight Center (GSFC).

Center, and asked for help. Early in February, Townsend wrote a long, careful letter to Newell to confirm the arrangements. Townsend outlined two missions for his division. The primary mission was [102]

> to plan, organize, and conduct a broad program of basic research in space science through the use of experiments flown in sounding rockets, Earth satellites, and space probes. The program is to be pursued vigorously with all available assets and is to be forward looking in its objectives. This broad based program will be a part of the NASA national program in space science formulated by the Office of the Assistant Director for Space Sciences.

Townsend's use of the phrase "formulated by the Office of the Assistant Director" rather than "approved by" specified a role for NASA Headquarters quite different from the role that the old NACA Headquarters had played for forty years. This new role for Headquarters would lead to considerable friction between Newell and powerful center directors accustomed to the role of NACA Headquarters. In the NACA, center directors planned programs and sought funding from a technically weak headquarters staff. Townsend's letter was prescient, and after some bruising battles, NASA Headquarters began to formulate and control NASA's programs.

In the meantime, who would help Newell formulate the national program in space science? Townsend's letter listed a secondary mission for the Space Science Division: [103]

> to provide the Assistant Director for Space Sciences with support, in the form of staff consultants, project managers, working group members, and contract monitors, in the formation and conduct of the NASA national program in the space science area.

Townsend's letter carefully distinguished between "staff consultants" and "project managers, working group members, and contract monitors." Staff consultants would report to Newell or a member of his staff at Headquarters; the others would report to Townsend at Goddard. According to Townsend's letter, Newell's staff would select scientists on a competitive basis from all proposals submitted.

Despite Townsend's careful specification of the secondary mission for the Space Science Division, it placed the senior Goddard scientists, who worked part time at Headquarters, in a conflict of interest—a scientific, rather than a legal conflict of interest. At the Center, they wore "Center research hats" and conducted their own research projects; at Headquarters they wore "Headquarter's scientific-statesmen hats" and helped Newell formulate the national space science program. At the Center they worked on their own, or managed their subordinates', research projects; yet at Headquarters they were expected to make objective decisions about the research programs of other scientists—who were in direct competition for the same resources in NASA's national space science program. In addition to placing these Center scientists in a scientific conflict of interest, this arrangement also made them vulnerable to charges that, in their review of proposals at Headquarters, they could steal a competitor's ideas and incorporate them into their own research projects.

Despite the scientific conflict of interest, Newell's and Townsend's arrangement might have worked if space scientists had continued to be in short supply. Then the Goddard scientists would have spent their time trying to persuade scientists to undertake space experiments. Unfortunately for the success of Newell's plans, by the fall of 1959, he had far more space scientists than he had spacecraft to carry instruments. He needed scientists free of any scientific or legal conflict of interest to evaluate proposals and set priorities.

Newell could have turned to the Space Science Board for help but it is clear from his book that he did not want the Board to be involved in the day-to-day operation of the program. According to Newell, Dr. Hugh Odishaw, executive director of the Board, urged NASA to use the Board to plan the space science program and to use academic scientists rather than hiring more NASA scientists. Newell resisted, arguing that NASA needed to have increased scientific competence in order to work with the outside scientific community.[104]

In order to control the program and carry out the wishes of Congress and the Administration, Newell had to be in charge—something he could not accomplish if the Space Science Board planned the program and selected the scientists. The Board deliberated, made motions and consumed valuable time, while the Russians sprinted further ahead and Congress berated NASA for its failure to catch up.

The Unmanned Race to the Moon

During 1959, the United States and the Soviet Union raced to send unmanned spacecraft to the Moon. The United States kicked off the race in the fall of 1958 with three unsuccessful attempts to fly a spacecraft past the Moon. On January 2, 1959, the Soviets responded to the American challenge. On their first attempt, the USSR launched Luna I. It flew out of the Earth's gravitational field, sailed past the Moon and drifted into orbit around the Sun. Two months later, on March 3, 1959, NASA's Pioneer IV followed Luna I past the Moon and on into a solar orbit. Although Pioneer IV provided valuable information on the radiation belts, it gathered no information about the Moon and did little to restore American confidence in its space technology.

In January 1959, embarrassed by the failure of the first three

Pioneers to fly by the Moon and startled by the Soviets' success on their first attempt, Dr. T. Keith Glennan, NASA administrator, approved the first NASA lunar project.* This was to be a crash project to capture the lead in the race to the Moon by launching a spacecraft into lunar orbit by the fall of 1959. Glennan approved a proposal by the Space Technology Laboratories (STL) to use a new launch vehicle, the Atlas-Able, to place a 120-kilogram spin-stabilized, solar-powered spacecraft in orbit about the Moon.

NASA wasted no time soliciting proposals from scientists for these four lunar missions; STL proposed the scientists and NASA accepted them.

The Soviets, the fates, the media, and the Congress all lashed NASA in 1959. Even as NASA and STL struggled to prepare the lunar orbiter for launch, the Soviets extended their lead in lunar exploration. On September 14, 1959, they scored another first when Luna II struck the surface of the Moon. Two days later, the *New York Times* carried three stories on space. One quoted Nikita Khrushchev, who spoke at the Press Club in Washington, and hailed "the victorious USSR rockets." Another described an explosion at Cape Canaveral of a Jupiter rocket carrying 14 pregnant mice and two frogs. A third quoted President Eisenhower telling 600 foreign exchange teachers that it was more important to orbit ideas than satellites.[105] On September 20, The *New York Times* carried the headline, "Russia's Moon Shot again demonstrates its lead in space race." [106]

A month later, on the second anniversary of Sputnik I, the USSR launched Luna III. Three days later, they scored again when Luna III photographed the back face of the Moon, the face that is invisible from the Earth. On October 10, the *New York Times* carried another article on space with the headline "US Space Program Far Behind Soviets." [107]

Two months later, almost exactly two years after the first disastrous Vanguard launch, the international media once more assembled at Cape Canaveral to watch the Americans humble the Soviets. Once more America took a mighty swing and fanned out. At 1:32 a.m. Thanksgiving Day, November 26, 1959, the first Atlas-Able carrying a lunar orbiter roared ponderously off the pad. Forty-five seconds later, the fiberglass shroud covering the spacecraft blew off and the rocket broke up, dumping the lunar orbiter into the Atlantic.

Again Americans had a long weekend to worry about their position in the space race. The media made sure they understood their

---

* The first four Pioneers were started by DOD's Advanced Research Projects Agency prior to the formation of NASA.

position. On November 29, the *Washington Star* proclaimed, "U.S. Out of Space Race for at Least 2 Years."[108]

This crash project to beat the Soviets irritated the scientists involved. The scientists had wasted their time; they had developed their instruments, battled the STL engineers for the right to build and test them, and now the instruments lay on the bottom of the Atlantic Ocean. The frustrated scientists complained to Lloyd V. Berkner, chairman of the Space Science Board. Their complaints helped precipitate the major review of NASA's policies that is discussed in chapter 6.[109]

With a presidential election approaching, the Democrats took off in full cry after an elderly, ailing President and his party. On October 28, 1959, Congressmen Overton Brooks, chairman of the House Committee on Science and Astronautics, announced his intention to hold hearings on why the United States was lagging behind the USSR in space. On December 17, Senator Lyndon B. Johnson, Senate Majority Leader, made a speech blasting the Administration for America's lack of progress in space. He said, "We cannot concede outer space to communism and hold leadership on Earth."[110,111]

Not all U.S. launches failed in 1959. Out of the glare of publicity over the race to the Moon, Silverstein and his team quietly moved ahead in several areas. On February 17, Vanguard II carried a camera into orbit to photograph clouds. Although the satellite did not operate properly, and was unable to transmit daily pictures of the clouds, it was the interest in the Vanguard II photographs of the Earth that led to the daily cloud cover maps shown on today's TV news. On August 7, a Thor-Able rocket placed a 64-kilogram spin-stabilized, solar-powered satellite, Explorer VI, in an eccentric orbit around the Earth. Although the power supply for this satellite failed two months after launch, scientists obtained excellent data on the properties of the radiation belts and the effect of solar activity on cosmic rays.

In 1959, NASA succeeded in eight of its fourteen launch attempts. Of the ten space science launches, however, only four were successful. Space science lagged behind badly in 1959. The other four successful launches tested the Mercury capsule, the spacecraft destined to carry the first American astronaut into orbit.

Scientists Recognize the Potential of Space Research

Meanwhile, during NASA's first troubled year, many scientists came to recognize the potential and understand some of the problems of space science. Scientists left their quiet laboratories in increasing numbers during 1959 to seek the opportunities and brave the uncertainties of research using instruments launched atop a roaring rocket.

Physicists and astronomers wanted to station their detectors and telescopes outside the Earth, beyond its atmosphere and its magnetic field. Planetologists, geologists, and atmospheric physicists wanted to fly their instruments to the vicinity of, or place them on the surface of, the Moon and the planets.

Physicists also wanted to answer questions about cosmic rays, the energetic electrons and atomic nuclei that continuously rain down on the Earth. Where did they come from? How did they get their enormous energies? What caused the variations in their flux? What could they tell us about the origin of the Earth, the solar system, and the universe?

During the decade prior to Sputnik, these cosmic ray physicists, sponsored by the Office of Naval Research, used balloons and aircraft to carry their instruments as close to the top of the atmosphere as possible and to the poles and the Equator. They pushed an unreliable balloon technology, through the use of ever thinner materials and ever larger balloons, to reach higher and higher altitudes. They needed the higher altitudes and longer exposure times to study lower energy and more pristine cosmic rays whose properties had not been changed by passage through the Earth's atmosphere and magnetic field. Accustomed to an studying results from eight-hour flights using unreliable balloons once or twice a year, these physicists desperately wanted to put their detectors on a spacecraft that would fly for months or years in interplanetary space and be completely free of any disturbance from the Earth.

Van Allen's discovery of the radiation belts in 1958 and his instant global acclaim further whetted their appetites. Already experienced in designing and building their own instruments to work unattended on a balloon, they flocked to NASA. They were accustomed to spending a year or more preparing an experiment and conducting joint balloon-flying expeditions with their colleagues. Some believed that a satellite would be like using a larger more reliable balloon—they sometimes forgot that whereas a balloon rises slowly and majestically from the ground, gently floating its payload into the sky, a rocket blasts its payload into the sky and tries to shake it to pieces.

Astronomers wanted to put their telescopes into orbit. Throughout the centuries they had climbed the highest mountains and scanned the darkest skies to make their observations. To an astronomer, a satellite provided the ultimate mountaintop. After World War II, a small group of astronomers at the Naval Research Laboratory (NRL) began to use sounding rockets to carry their instruments above the atmosphere for a momentary glimpse of the solar or stellar radiation absorbed by the atmosphere. Another group at Princeton used balloons to carry telescopes into orbit. Some of the NRL astronomers moved to the Goddard Space Flight Center (GSFC) in late 1958. The rest stayed at NRL, continued their work using Navy-supplied rockets, and sought opportunities to fly their instruments on NASA satellites. During 1959, because of the interest generated by the Space Science Board and by astronomers at Goddard, many astronomers switched from ground- to space-based astronomy. A few joined the space science divisions at Goddard or JPL, but most stayed at their original observatory.

Space flight created a new discipline, planetology, and revived a moribund branch of astronomy: planetary astronomy. At the turn of the century, astronomers lost interest in the planets when they realized that no matter what they did with telescopes, their ability to view objects on the surfaces of planets was limited by the distortion of the image as it came through the Earth's atmosphere. Space flight offered the opportunity to physically send instruments to orbit the planets or land on their surfaces. Planetologists wanted to study the planets to answer such questions as, What was their present state and how had they evolved? What could they tell about the origin, evolution, and future course of the Earth? Where did they come from? What kind of atmospheres did they have? In 1959, one of the most exciting questions was whether life existed on the other planets. Were the "canals" on Mars from an ancient civilization? Did an exotic civilization exist under the clouds of Venus? Planetology, as a scientific discipline, did not exist prior to space flight. Geologists, physicists, astronomers, and biologists all became planetologists.

Unlike the physicists and astronomers, planetologists had no cadre of experienced scientists to show them the way. They found powerful allies, however, among the media and aerospace engineers, particularly those at JPL. In 1959, designing a spacecraft to fly to a planet was a formidable engineering challenge. To arrive there would demonstrate exquisitely honed engineering and management skills. The first photographs taken at close range of the Moon's surface or of a new planet dominated the front pages of newspapers and flashed on the evening television news programs. The question of the existence of life on other planets fascinated scientists, the media, religious leaders and philosophers alike. The public too, could comprehend and identify with a picture-taking mission to Mars or Venus but had little interest in a graph that showed the flux of cosmic rays as a function of the distance from the Sun.

Scientists Discover the Problems in Space Research

Scientists entering the field of space science soon learned what the pioneering members of the Upper Atmosphere Rocket Research Panel had learned during the preceding quarter century—research using rockets was a hazardous and uncertain profession. To scientists who worked in the quiet of their laboratories, research was a continuous process. One made measurements, analyzed the data, published the results. Out of that work one gained new insights, asked new questions, modified the existing experimental apparatus, and started the whole process over again. The process continued from month to month and year to year. Scientists who moved from the laboratory into space science found their research work broken into discrete missions and the weight of their instruments severely restricted by the launch vehicle's limited weight-lifting capability. They learned that a mission, after a year or more of preparation, inundated them with an ocean of data that NASA and the media wanted analyzed and interpreted immediately. They also learned that the rocket might explode, or NASA might cancel the mission and leave them with nothing to show for a year's work.

The nature of space science required scientists to plan their experiments in great detail. Scientists had to design rugged instruments that would fit within the confines of the rocket and endure the shock and vibration of a launch. In addition to the flight instrument itself, a NASA project manager might require an "engineering model" of an instrument so his engineering team could figure out how to fit it on the spacecraft, a "thermal model" so they could check for hot spots, a "breadboard model" so they could eliminate any electrical interference with other experiments or the spacecraft itself, and finally a "brassboard model" to check the fittings on the spacecraft prior to integrating the actual flight instrument. Scientists found that they needed a small engineering staff or a contractor to build all of these models and work with the project manager's staff.

If it survived the shock and vibration of launch, then an instrument had to operate unattended for months, in the heat of the Sun and the cold and vacuum of space. The radio signals from the spacecraft had to be collected by ground stations scattered around the world and then converted back into physical measurements. After this if the instrument operated properly, the scientist began to analyze the data and, finally, published some results.

A scientist from a university, accustomed to having his or her instruments built in his or her laboratory, and a project manager from the Jet Propulsion Laboratory, accustomed to the schedules and constraints of a military aerospace project, each was appalled by the work habits of the other. A harassed project manager hated to depend on an eccentric scientist soldering away in the basement of a physics department to produce reliable space hardware and meet tight schedules. Scientists were loath to turn their precious instruments over to engineers who were interested in whether the instruments could pass their environmental tests rather than whether the instruments could measure the phenomena. Some hard-nosed project managers, primarily from JPL and aerospace contractors, directed scientists to give designs of their instruments over to contractors who could "build space-qualified hardware" but who, in fact, might build instruments that worked in space but produced useless data.

Academic scientists who worked with the Goddard Space Flight Center in 1959 were more fortunate. Most of the Goddard project managers were ex-NRL scientists who had built instruments to fly on rockets or satellites. They understood and were sympathetic to the objectives of the academic scientists. They demanded as little paperwork as possible.

Elsewhere, particularly at JPL, scientists and project managers quarreled over the purpose of a mission. Was it to return scientific data to scientists or demonstrate to the world that NASA could design, build, and send a spacecraft to the Moon or one of the planets? In the first year of NASA's existence, the NACA engineers, who had spent their careers studying and improving the behavior of machines in the atmosphere and space, focused their attention on the hardware, not space science. Aerospace engineers, accustomed to building and making missiles work, and operating under the glare of the media, focused their attention on the spacecraft and resented the interference of scientists with experiments that might delay the launch schedule and cause the United States to lag further behind the Russians.[112]

In 1959, in spite of mounds of paper, acrimonious debates, delays, exploding rockets, and NASA cancellations, scientists continued to flock to space science. Scientific discoveries, a place in history, prestige, power, membership in the National Academy of Sciences, ample funds, and enthusiastic graduate students all drove scientists to fight to find a place for their experiments on NASA missions.

Goddard's Tennis-Shoe Crowd

During 1959, the burgeoning interest in space science, the scientific momentum generated by the IGY, and the Center's active recruiting program brought many young scientists into the space science division at Goddard. Some came from other government laboratories or industrial laboratories, but most were assistant professors or research associates with new doctorates who left their universities to come to Goddard. Most came because they thought they would have a better chance to get their experiments flown if they were at a NASA flight center. Some came because they didn't like the academic life. Many were veterans of World War II who had obtained part of their education under the GI Bill. Most obtained their doctorates in a professional culture that had been nourished for the past fifteen years by the Office of Naval Research (ONR). Almost all came with a somewhat different professional outlook than the cadre of senior civil service scientists who had transferred from NRL to Goddard at the end of 1958.

In the universities these young scientists had learned how to conduct research by working as assistants on research projects supported by ONR. Their professors encouraged them to select their own theses topics and allowed them to proceed with a minimum of supervision. They learned to invent and build their own equipment. The professors allowed them freedom to publish research results where they wanted, as long as they were published in a reputable scientific journal, such as the *Physical Review*, where their work would be refereed by their scientific peers.

When these young, aspiring space scientists arrived at Goddard, they were dismayed by the paperwork associated with procurement and travel. They rejected any notion of sending their articles to NASA Headquarters for clearance or publishing their work in NASA journals. These scientists looked to their scientific peers for professional acclaim, not to the administrative hierarchy at Goddard or NASA Headquarters. They became known around NASA, sometimes affectionately, as that "Goddard tennis-shoe crowd."

The members of Goddard's tennis-shoe crowd were much more concerned with the latest results in their research field, and in their own instruments and research, than they were with Center politics. The necesssity of courting patronage, however, drove them out of their laboratories and into the political and management arena. They needed missions scheduled and spacecraft built that allowed them to conduct their research. Then they had to make sure they were among the scientists selected for those missions. They regarded rockets and spacecraft as essential scientific tools and were willing to spend the time and energy that was required to make them more useful. For instance, if they needed magnetically clean spacecraft* to measure weak interplanetary magnetic fields, they worked along with the Goddard engineers to design a spacecraft with minimal magnetic fields and then monitored the contractors to make sure they built them right. They undertook this work primarily to meet their own research needs, but the techniques they developed and the magnetically clean spacecraft they built could also be used by their academic colleagues.[113]

* A spacecraft whose materials and electric wiring were designed to reduce or eliminate spurious internal magnetic fields.

In 1959, however, any benefit that might accrue to an academic scientist from having a Goddard scientist help design a scientific spacecraft lay several years in the future. Academic scientists looked at Goddard scientists as competitors with an unfair advantage because they had ready access to NASA's decision makers. Conversely, Goddard scientists saw their academic colleagues as competitors with an unfair advantage because they had ready access to the academic members of the powerful Space Science Board that evaluated proposals and assigned flight priorities. Goddard scientists did not serve on the Board, because, in order to avoid a conflict of interest, NASA and the National Academy of Sciences had agreed that no NASA scientist could serve on the Board. As a result of this policy, no NASA scientist, not even those who were members of the National Academy of Sciences, ever served as a member of the Board.

Selection of Scientists for the Early Goddard Missions

The Goddard Space Flight Center managed most of NASA's early unmanned Earth-orbiting satellite missions. Some of these early missions were started by ARPA and then transferred to NASA on October 1, 1958. In late 1958, with Glennan's approval, Silverstein appointed a project manager for each scientific mission that had been assigned to the Goddard Center, whether it was an existing ex-ARPA mission or a new NASA mission. The first project managers that he appointed were mostly scientists who had transferred from NRL.

In the fall of 1959, Harry Goett, the director of Goddard, replaced almost all the project managers who were scientists with engineers. At the same time, he appointed a project scientist for each scientific mission. The project manager directed the day-to-day work on the mission and was responsible for the overall success of the mission. The project scientist oversaw the work of the scientists who had experiments on the mission and made sure that the mission accomplished its scientific objectives: He had to resolve any conflicts that arose between the scientists and the project manager.

Starting in early 1959, Goddard scientists, either in their role as project managers or as project scientists, began to organize these new NASA missions. Goddard scientists selected the scientists who flew instruments on Explorers VIII, X, XI, and XII. In selecting the scientists for these four Explorers, neither Goddard nor NASA Headquarters solicited proposals from the scientific community or told them of their intention to conduct a mission. In most cases, however, the Goddard scientists selected scientists who had responded to Berkner's 4th-of-July telegram and whose proposals had been reviewed and recommended for flight by the Space Science Board in December 1958.[114]

The selection process used by the Goddard scientists was complex. Three examples will illustrate how they proceeded, some of the forces that affected their decisions, and why academic scientists became concerned.

Explorer XII

Explorer XII, designed to study the Earth's magnetosphere and cosmic rays, was one of the first missions initiated by Goddard. Leo Davis, a scientist from NRL, was the initial project manager. In the fall of 1959, Goddard's management appointed a new project manager and a project scientist for Explorer XII. Dr. Frank B. McDonald, a cosmic ray physicist who had left the State University of Iowa in August to join the Goddard, was appointed the project scientist. McDonald was one of the first project scientists appointed by Goddard; his work on Explorer XII established a precedent at Goddard that gave a great deal of authority and responsibility to future project scientists.

When McDonald took over as project scientist, he found that one scientist, M. Bader, a plasma physicist from NASA's Ames Research Center, had already been selected by the newly designated director of Goddard, Harry Goett. Bader had no previous experience as a space scientist. His experiment had not been reviewed by the Space Science Board. Prior to coming to Goddard, Goett had been the associate director of Ames, knew Bader, and thought his experiment should fly. McDonald decided to use the remaining capability of the spacecraft to add a cosmic-ray experiment, a magnetic-field experiment, and a trapped-radiation experiment. McDonald chose his own cosmic-ray experiment. He chose Leo Davis, the former project manager and now a member of McDonald's branch, to provide another cosmic ray experiment. Although there was a strong magnetometer group at Goddard in McDonald's branch, he decided that there should be more academic scientists involved in the mission. Therefore, he chose Dr. L. Cahill to conduct the magnetic-field experiment. Cahill had recently moved from the State University of Iowa to the University of New Hampshire. Finally, McDonald chose Dr. B. J. O'Brien from the State University of Iowa to conduct the trapped-radiation experiment because he had an experiment that could meet the weight constraints on the payload. Earlier, in 1958, the Space Science Board had reviewed and approved for flight, experiments proposed by McDonald, Davis, Cahill, and O'Brien.[115,116,117,118]

In the absence of any formal NASA or Goddard process for selecting scientists, McDonald chose a highly competent group of scientists for Explorer XII. All of their instruments, except for Bader's, provided excellent data. There were, however, other equally competent scientists whose experiments had also been reviewed and recommended for flight by the Space Science Board. These people questioned the propriety of McDonald's selection. To them, looking at the list of experimenters, it appeared as if McDonald had selected himself, two former colleagues at Iowa, a scientist who worked for him at Goddard, and an unknown scientist from another NASA center.

Orbiting Solar Observatory

In 1959, Dr. John Lindsay, initially the project manager and later project scientist for the first Orbiting Solar Observatory, OSO I, assembled the payload for that mission. OSO I, designed to study solar radiation, used a large spinning "wheel" to stabilize the satellite and point a platform at the Sun. Lindsay selected twelve scientists, eight of whom were colleagues at Goddard and four who were from universities. In this case, most of the payload space was on the rotating wheel of the OSO spacecraft and not considered a particularly good place for an experiment, so Lindsay had a difficult time finding scientists who were interested in preparing experiments for the wheel. To fill up the wheel, he turned to his colleagues at Goddard.[119]

Explorer VIII

Also during 1959, Robert Bourdeau, acting as both project manager and project scientist for Explorer VIII, an ionospheric physics mission, selected the scientists for that mission. He selected himself and four colleagues at Goddard to conduct the five experiments. Bourdeau's experiment had been reviewed and approved by the Space Science Board with himself and Dr. John F. Clark as co-investigators. In October 1958, after he accepted a position on Newell's staff at NASA Headquarters, Clark withdrew from the experiment to avoid any conflict of interest.[120,121,122]

For each of these missions, the senior management of Goddard reviewed the list of scientists selected and then sent it on to NASA Headquarters, where Newell and his staff reviewed and forwarded it to Silverstein for approval.

In addition to competing with the Goddard project scientists, academic scientists who came to NASA Headquarters to discuss a flight proposal quite frequently found themselves discussing the proposal with someone from Goddard who was either a competitor, or who was supervising a group of scientists at Goddard who were their competitors, for the same opportunities to fly on NASA missions. The Goddard scientists attended Newell's staff meetings and in general performed the same tasks as the permanent members of Newell's staff.

By the fall of 1959, academic scientists were seeing the major share of the payload space on Goddard missions being assigned to Goddard scientists—an intolerable situation. Scientists who were not from NASA and who felt Newell's hybrid organization did not give them a fair chance to compete complained to Newell, the Space Science Board, and the President's science advisor.

Newell's Conflicts with Goddard

Academic scientists were not the only scientists who raised their voices against Newell's hybrid organization. Some of the scientists at Goddard complained that neither JPL nor Newell's staff at NASA headquarters gave fair consideration to their proposals to fly experiments on JPL lunar and planetary missions.[123]

Next, Harry Goett, the new director of Goddard, a long-time NACA employee and firm believer in a strong role for center directors, complained to Newell about the use of Goddard scientists at Headquarters. Goett did not want his scientists to work directly with Newell to arrange missions that Goddard would then have to carry out. Goett wanted his scientists to prepare their plans at Goddard, present them to him, and then he would work out the arrangements with his boss, Abe Silverstein. That was the way the center directors of the NACA had operated and that was the way he wanted to operate. After Goett's complaint, there is no record of any Goddard scientists attending Newell's staff meetings. Also Newell hired additional scientists to work in Headquarters, thereby reducing the need for Goddard scientists.[124]

Newell's Conflicts with JPL

Throughout 1959, Dr. William H. Pickering, director of JPL, opposed Newell's mode of operation. At the end of 1958, after JPL was transferred from the Army to NASA, Silverstein asked the Laboratory to begin planning lunar and planetary missions. Pickering created a Space Science Division and appointed Dr. Al Hibbs, a physicist from the California Institute of Technology, director of the Division. Pickering expected Hibbs to work directly with the Space Science Board and those scientists interested in lunar research. Hibbs was to plan missions and select the scientists to work on them. Pickering himself also expected to review these missions and their payloads before sending them to NASA Headquarters for review by Newell and approval by Silverstein.

Newell took a different approach. He asked Dr. Robert Jastrow * to chair an ad hoc "Working Group on Lunar Exploration" to help him plan the lunar exploration program. Newell expected Jastrow and his group to evaluate proposals, select scientists, and propose payloads

---

* Newell's friend and former colleague at the Naval Research Laboratory (NRL) who had been appointed director of the Theoretical Division at GSFC early in 1959.

for him take to Silverstein for approval. After approval, Newell expected Silverstein to direct JPL to negotiate contracts with the scientists selected and incorporate their experiments into the spacecraft.

In February 1959, Jastrow's group recommended a series of lunar experiments. These included gamma-ray experiments to assay the lunar material, magnetometers to measure the lunar magnetic field, and seismometers to measure seismic activity on the Moon. Silverstein approved these experiments and directed JPL to include them on lunar missions. During the summer of 1959, Hibbs and his staff and Jastrow and his working group sought to find mutually acceptable experiments for lunar missions. By fall, they had tentatively agreed on the priority of experiments for a series of six flights to test a new rocket system. In December, NASA Headquarters canceled the test flights as well as the rocket system.

Meanwhile, Pickering and his staff prepared a five-year plan for lunar and planetary exploration that they submitted to NASA in April 1959. In its plan, JPL scheduled a mission to Mars in October 1960, Venus in January 1961, a rough lunar landing in June 1961, and a lunar orbiter in September 1961.[125]

As discussed earlier, the success of Luna I in January 1959 and the prospect of additional Soviet lunar missions led NASA Headquarters to focus on lunar missions. In the summer of 1959, Silverstein directed JPL to cancel the Mars and Venus missions and focus its work on lunar missions.. This emphasis on the lunar program further irritated Pickering, who thought that the NASA program should emphasize planetary missions. To Pickering and his staff, eager to work on the frontiers of technology, a planetary mission was the supreme challenge. They were unhappy with the NASA Program, with NASA management, and with Newell's process for selecting scientists for JPL missions.

Newell's Conflicts with the Space Science Board

In early 1959, the Space Science Board still thought that NASA faced a shortage of competent scientists to undertake research in space. The Board continued to encourage scientists to enter space research, to formulate the space science program, and to recommend experiments for NASA missions. In April 1959, the Board and NASA conducted a joint seminar in Washington, D. C. to stimulate interest in space science.

In July, the Board published a lengthy article in *Science*. The article encouraged scientists to propose space science experiments to NSF and NASA. It discussed the engineering problems involved in designing space hardware. In the article, the Board gave itself a well-deserved pat on the back, noting that it had successfully solicited and selected experiments and that NASA had adopted its recommendations.

The Board also noted that "the rapidly developing strength and competence of the NASA" enabled the Board to devote its efforts to the "longer-term problems in space research." In addition, the article reiterated the intention of the Board to operate in the traditional advisory mode of the National Academy of Sciences, rather than engage in any operational role in space science.

According to the article, provision for the "operational aspects of the conduct and support of space research has been made by law in the establishment of the government agencies cited above." The agencies cited were NASA, NSF, and ARPA. Here the Board was wrong. The Space Act made only one agency, NASA, responsible for the conduct of civilian space research. The Board wanted to keep the National Science Foundation involved in space science and to keep the conduct of the scientific research separate from operations, rockets, spacecraft, and tracking stations.[126]

Six days after the article was published, and despite the statements in the article that the Board would not get involved in operations, Dr. Hugh Odishaw, executive director of the Board, sent an urgent request to the members of the Board asking for their recommendations for a ten-year space science program. They were asked to specify experiments, group the experiments into payloads, and designate the scientists who had the competence to conduct them.[127]

The Board continued with its self-assigned tasks through most of 1959. On October 29, 1959, using the power of the purse, NASA firmly took the Board out of program planning and selection of space scientists. The contract to support the operation of the Board was up for renewal. A Work Request was needed to describe the tasks NASA wanted the Board to undertake in the coming year. The deputy administrator of NASA, Dr. Hugh F. Dryden, signed a Work Statement that accompanied the funds NASA provided for the Board in Fiscal Year 1960. This work statement, prepared by Newell, outlined NASA's interest in the Board as follows:[128]

> NASA . . . would like to have from the Space Science Board a continuing input of thoughts, ideas, and recommendations on the broad overall objectives, and the course that the space science activities in the United States should take. A prime question is: What are the basic philosophical objectives that should underlie the space science activities and program: Guiding principles are needed, rather than a detailed program formulation, which must be worked up in the NASA in consideration of a variety of factors, such as budget, availability of rockets, testing facilities, the balanced program emphasis between space sciences and other NASA activities . . .

From the Board NASA wanted long-range strategic planning and help in justifying space science, not guidance or participation, in its day-to-day operations.

On November 13, 1959, the chairman of the Board, Lloyd V. Berkner, reported on the status of the nation's space science program to the chairman of the President's Science Advisory Committee, Dr. George Kistiakowsky. In the transmittal letter, Berkner stated that: [129]

> upon request of the NASA, the Board is now turning its attention to the development of recommendations concerning the longer range objectives of space research and will plan also to give consideration to such matters as the basic philosophical objectives which should underlie space science. . . .

In February 1960, Odishaw sent a memorandum to the committee chairmen. He directed them to refocus their attention, to turn from missions and evaluation of experiments to the nature and scope of the U.S. space program for the coming years.[130]

The final meetings of the Board's seven discipline committees took place in 1960. The NASA scientific subcommittees described in chapter 6 took over the functions of planning the scientific program and evaluating proposals. Hereafter NASA, not the Board, formulated the space science program and selected the scientists to conduct it.

However, the Board assigned itself another function—oversight of NASA's performance. In his November 1959 report to Kistiakowsky, Berkner used this function. He did not like the way NASA and its contractors were treating scientists and he raised this issue in the report to Kistiakowsky: [131]

> In one case, a particularly vicious practice has grown up of excluding the scientist from the payload engineering. . . . This practice is not suitable for space activity, should not become imbedded in its procedures, and should be terminated forthwith by cancellation of contracts that insist on this procedure.

Berkner did not identify the "case," but presumably Space Technology Laboratories, racing toward the launch of the lunar orbiter by Thanksgiving, was the culprit. Berkner would concede the legal obligation and practical necessity for NASA to plan and conduct the space science program, but he would retain the right of the Space Science Board to oversee the work and criticize NASA's performance directly to the President's Science Advisory Committee, rather than to the administrator of NASA. The failure of the launch vehicle for NASA's lunar orbiter over Thanksgiving weekend added credence to Berkner's criticism of NASA and the contractor's performance.

Glennan Cancels Vega and Reorganizes NASA

Early in 1959, NASA had directed the Jet Propulsion Laboratory to build a new Vega rocket. Vega was to be placed atop the Atlas to provide the additional velocity needed to place a spacecraft in orbit about the Moon or fly it past Mars or Venus. NASA intended the Atlas-Vega to be the workhorse for lunar and planetary exploration for the next several years. JPL prepared a five-year plan for its use. At about the same time, the Air Force started work on the Agena, a classified upper stage for the Atlas, to be used to launch reconnaissance satellites. This Atlas-Agena combination could launch a lunar orbiter or send a spacecraft by Mars or Venus. Ten months later, NASA found out about the Atlas-Agena rocket, and, faced with a constrained budget, arranged to use the Atlas-Agena to launch its lunar and interplanetary missions.

On December 11, 1959, Dr. T. Keith Glennan, reorganized NASA and arranged to transfer the Army's Development Operations Division * and the Saturn Project to NASA. No longer needing the Vega, Glennan also canceled that project, much to the consternation of the several hundred JPL engineers who were working on it and the scientists who were building instruments to fly on the six test flights of the Atlas-Vega.[132] These actions increased the tension between JPL and NASA Headquarters, added to the irritation and confusion of space scientists, and helped force Newell to abandon his hybrid space science organization, establish a strong space science organization at NASA Headquarters, and bring the process for the selection of space scientists into NASA Headquarters.

On December 16, 1959, Richard E. Horner, associate administrator of NASA, wrote to Dr. William H. Pickering, director of JPL, to inform him that the Vega Project had been canceled. In the same letter, Horner assigned Pickering the job of planning and executing NASA's lunar and planetary space exploration program.[133] Pickering promptly seized upon this new assignment to resolve his conflicts with Newell over the selection of scientists for lunar and planetary missions. He requested Silverstein to remove Jastrow as chairman of the Working Group on Lunar Exploration and replace him with Al Hibbs, director of

* Wernher Von Braun's organization, which had launched Explorer I and was responsible for developing the Saturn.

the Space Science Division at JPL.[134] Silverstein ignored Pickering's request and on December 21 sent him a letter that started with the words: [135]

> Based on a study by the several groups in the Headquarters staff participating in the lunar and deep space program, the following tentative flight program and mission designations have been established as a starting point for determining a post-Vega program.

Silverstein's letter specified five lunar missions, two missions to Venus in 1962 and two to Mars in 1963. It directed the laboratory to develop a system to transmit high resolution pictures of the lunar surface back to the Earth. Silverstein's letter made it clear that NASA Headquarters would formulate the lunar and planetary program and decide which experiments would be flown. He notified Pickering that several people from his staff would visit JPL on December 28 to work out any problems that JPL had with the program.

A Crucial Meeting at JPL

With all these issues coming to a rolling boil, Newell and three members of Silverstein's staff flew to California on December 27, 1959 to meet with Pickering to resolve the problems between NASA Headquarters and JPL. The following material is based on the lengthy memo that Newell prepared after his return to Washington.[136]

Using Silverstein's December 21 letter as an agenda, the group considered problems of spacecraft, launch vehicles, and schedules for lunar missions and agreed that JPL should immediately start work on what would become the Ranger and Surveyor missions to the Moon.

After a long morning session, Newell, Pickering, Goddard, and Hibbs held a rump session to battle out the method of selecting scientists to conduct experiments on JPL lunar and planetary missions—issues raised by Pickering's letter to Silverstein. The group agreed on a policy for the selection and role of space scientists. Under this policy, NASA would establish a mission and Silverstein's Office of Space Flight, in collaboration with JPL, would select a tentative group of scientists for it. They would select more experiments than the spacecraft could carry. Subsequently, the excess scientists and their experiments would be eliminated prior to Silverstein's approval of the final selection. The experimenters would build prototype models of their experiments that JPL would then examine to determine if they were suitable for flight. With the advice and concurrence of Newell's office, JPL would make the final selection of experiments and experimenters for the mission. JPL would build the experiments, or direct a contractor to build them, based on specifications prepared by the experimenter.

This policy, as described in Newell's memo, would have made NASA Headquarters responsible for the initial selection but allowed JPL to determine if the experiment and the spacecraft were technically compatible. Thus, during the evaluation process, JPL could eliminate experiments it did not like. In addition, the policy would have made JPL responsible for building the flight version of the experiment, one of the procedures Berkner had complained about in his report to the President's science advisor. The policy would not have cut the scientist completely out of the fabrication process: he was to "assist JPL."

Experienced space scientists did not like this kind of arrangement because they knew they had to build their own apparatus to be sure the experiment made the measurements to the accuracy they wanted. Eventually, they would win the right to build their instruments but they did not win it in this particular meeting at JPL. One group, however, the University of Chicago Group under Dr. John A. Simpson, after their disastrous encounter with STL's engineers on Pioneer, insisted upon building their own flight instruments and overseeing their integration into JPL spacecraft.[137] In contrast to JPL, Goddard, the other space flight center, insisted from the beginning that scientists should build their own flight instruments, deliver them to Goddard, and then work with the project team to ensure that their instruments were properly integrated into the spacecraft.

According to Newell's memo, the group next considered the question of the chairmanship of the lunar science committee. While the chairmanship and membership of a committee were the immediate problems, the issues ran much deeper. A NASA Headquarters Lunar Science Committee existed. It was chaired by Dr. Robert Jastrow, theoretical physicist at Goddard. To Newell, Jastrow represented NASA Headquarters, not the parochial interests of the scientists at Goddard. To Pickering, Jastrow represented the Goddard scientists clamoring for space for their experiments on JPL missions. Such an arrangement—a Goddard scientist chairing a committee that planned the scientific program for JPL's lunar missions—was unacceptable to Pickering. Furthermore, Jastrow's committee had just recommended gamma-ray experiments for a lunar orbiter, a mission that, at that time, was not even in NASA's space science program. Clearly, to Pickering, a committee that was not close enough to the program to know what missions were scheduled could not be much help to JPL. Furthermore, as chairman of the committee, Jastrow reported directly to Newell at Headquarters.

Pickering cited Horner's week-old letter, which assigned JPL the responsibility for planning and executing the lunar program, and proposed, as we have noted, that Hibbs replace Jastrow as chairman.

Newell disagreed with Pickering's proposition: overall program planning was the responsibility of Headquarters. He, Newell, had already taken steps to set up such a committee, which he would chair. It would be an internal NASA committee and JPL would be invited to name a member. The group discussed the matter, and finally Newell agreed that a Goddard scientist should not chair a committee that established the scientific objectives or picked the scientists for JPL missions. Pickering agreed to a chairman from Headquarters and to limit the membership to people from NASA and JPL, while both agreed that it was important that the views of lunar and planetary scientists be heard by the committee.

Although neither Newell nor Pickering got exactly what he wanted out of the discussion and later events changed some of their agreements, this meeting did lead Newell to begin to abandon his hybrid space science organization and ultimately to formulate the policies and procedures that NASA has used for several decades years to select space scientists.

Newell returned to Washington and typed out a ten page "Memorandum for the Record" that described the meeting and the agreements he had reached. He signed about thirty letters and memoranda and went home to welcome a new year and a new decade of space science.

Lessons Learned in 1959

Abe Silverstein and his team at NASA Headquarters learned several important lessons about space science during NASA's first faltering year. They learned that a space science program had to be broken into discrete missions and each mission assigned to a specific center. Each mission should be assigned to a specific scientific discipline or, possibly, to two or three scientific disciplines, provided they all had similar requirements for the orientation of the spacecraft and the orbit in which it traveled. Each mission must have a group of scientists dedicated, for the duration of the mission, to accomplishing the scientific objectives. Each mission must have a project scientist who could work with the scientists selected for the mission and with the project engineering team responsible for developing, launching and operating the spacecraft. The project scientist was needed to understand and interpret the legitimate requirements of the scientists to the project team and to interpret and explain the project team's requirements to the scientists. One person, a project manager, must oversee the whole operation, get the instruments, spacecraft, and launch vehicle built, tested, and assembled and ready for launch. The project manager and the project scientist must work together to accomplish the objectives of the mission. Silverstein's team learned that the scientific objectives, technical requirements, and cost of a space science mission were interdependent and could not be separated at any management level.

At the end of 1959, it was clear that NASA needed a better process, and a well-documented process, for selecting scientists for its scientific missions. Competition among scientists was fierce. Academic scientists did not trust their competitors on the Space Science Board or those at the NASA field centers to make a fair selection. Scientists at JPL and at Goddard did not trust the Space Science Board or each other to make the selections for the missions assigned to their respective centers. NASA needed a process that would establish the United States as the leader in space science and that NASA and academic space scientists, the President's Science Advisory Committee, and the Space Science Board all had confidence in. It also had to be one that NASA center directors, project managers, and procurement officials could accept.

Chapter 6

THE NASA PROCESS FOR SELECTING SCIENTISTS

Some Preliminaries

Another Ad Hoc Arrangement with JPL

Upon returning to work in January 1960 Newell attempted to proceed as he and Pickering had agreed at their December 28, 1959, meeting. On January 26, 1960, a letter went from Silverstein to Pickering stating that he had "tentatively decided on the following course of action." [138] Even though NASA never proceeded on the course of action outlined in this letter, it is worth a brief consideration because it illustrates some of the problems Newell faced as he tried to design the NASA process for selecting space scientists. It also pinpoints exactly when Newell finally settled on the process for selecting space scientists.

The letter was obviously a trial balloon. It closed with a statement that nothing would be done until JPL responded. Edgar M. Cortright prepared the letter. Its content shows him as a young ex-NACA engineer, well on his way at NASA Headquarters, to becoming a master organizer of complex space activities. Cortwright tried to abide by Newell and Pickering's agreement and struggled to resolve the conflicts inherent in accomplishing the best possible science on a mission while keeping the mission on schedule and within predicted costs.

Instead of proposing a single committee, as Newell and Pickering had agreed on December 28, Cortright proposed two groups: a "steering group" and a "science committee." A "NASA Steering Group on Lunar, Planetary, and Interplanetary Exploration" would consist entirely of NASA and JPL engineers and scientists: four from JPL, one from Goddard, and five from NASA Headquarters. A "NASA Committee on Lunar, Planetary, and Interplanetary Science" would consist of about twenty scientists: three from NASA Headquarters, one from JPL, two from Goddard, and the rest from universities. Newell was to chair both groups.

The science committee would define the scientific objectives of the program, advise NASA as to the relative priorities of the proposed scientific experiments, and then specify the scientists and the instruments to be assigned to specific flights. The steering group would review the recommendations of the science committee, consider the technical, management, and budget problems of the lunar and planetary program, and develop an integrated lunar and planetary program. Cortright then recommended an alternate chairman for each group: himself, for the steering group, and Dr. Gerhardt F. Schilling, an astronomer who had joined NASA Headquarters, for the science committee. Cortright wrestled with the need to assign appropriate and complementary roles for the Space Science Board and the NASA science committee (almost all of the non-NASA scientists proposed were either members of the Space Science Board or one of its committees) by noting that the NASA scientific committee will "be more of a working group in direct support of NASA programs."

In hindsight, this proposed arrangement was unworkable. It was another scheme that mixed up the people and the roles of NASA Headquarters, Goddard and JPL. Since JPL was legally a contractor to NASA, JPL people could not legally participate in such discussions; they would be in a conflict of interest. In addition, this arrangement singled out the lunar and planetary program for special attention by NASA Headquarters. The instant that the physicists and the astronomers found out about such an arrangement they would have demanded a similar arrangement for their discipline. There was a limit to the number of committees even a hard-working chairman such as Newell could handle.

On the positive side, the arrangement recognized the need for a forum to balance the scientific objectives against the technical constraints imposed by the launch vehicle and the spacecraft and the limits imposed by the funds and personnel available to NASA. It recognized the need to describe and differentiate the roles of the NASA space science organization from those of the Space Science Board and its committees.

The arrangement also lacked a policy and set of procedures that specified how NASA would formulate its scientific program and select the scientists. Such a policy could not be written until there was a better understanding of the roles and responsibilities of Silverstein's office and the two space flight centers, Goddard and JPL. NASA records show no response from JPL to the Silverstein letter. Other events eliminated the need for a response.

Silverstein Reorganizes the Office of Space Flight

Silverstein needed to reorganize his staff and provide a better understanding of the roles of Headquarters and the field centers before Newell and his staff could design a suitable process for selecting space scientists. On February 7, 1960, Silverstein reorganized the Office of Space Flight Programs.[139] He made Newell his deputy, abolished Newell's Office of Space Sciences, and replaced it with two program offices: Lunar and Planetary Programs and Satellite and Sounding Rocket Programs. He appointed Cortright assistant director for Lunar and Planetary Programs and Schilling his Deputy. He appointed Stoller, director for Satellites and Sounding Rocket Programs and Clark, his deputy.

Silverstein's new organization paired a scientist and an engineer at each management level: Silverstein and Newell in Silverstein's office, Cortright and Shilling in the Lunar and Planetary Program Office, and Stoller and Clark in the Satellite and Sounding Rocket Program office. By pairing engineers and scientists at each management level, Silverstein assured himself that the scientific objectives and the engineering requirements received attention in all program decisions.

Silverstein's basic organization persisted for the next two decades in space science. The NASA selection process was designed around it. From the viewpoint of the scientists, however, Silverstein's organization had one major flaw: engineers, rather than scientists, were in charge at each management level. Engineers would remain in charge until a new administrator reorganized NASA in 1961.

Headquarters Becomes "HEADQUARTERS"

Silverstein's new organization eliminated the senior Goddard scientists and JPL personnel from decision-making positions at NASA Headquarters. Center people continued to have a strong influence on NASA decisions but they exerted that influence in recommendations transmitted through their center management to Headquarters, not as center people with "a Headquarter's hat" who worked in Headquarters. With center people no longer in decision-making positions at Headquarters, the roles and responsibilities of Headquarters and the two space flight centers could now be clearly delineated.

After the decision to eliminate the use of Goddard scientists at Headquarters, a predictable phenomenon took place. The people at NASA Headquarters, the "old NACA crowd," the "old NRL crowd," the scientists and the engineers, and the occasional stray scientist or engineer from industry or academia with no connections to either crowd, began to work together. They recognized that Headquarters must play a powerful role if the complex space science enterprise was to succeed. They gradually adopted the values and outlook necessary to work in Headquarters and separated themselves professionally from their roots in the field. Otherwise they retained the mores of their early training and remained "NACA" or "NRL" or "academic" and scientist or engineer.

Technical Management Instruction 37-1-1

Sometime in late January or early February 1960, Newell gave up trying to use ad hoc arrangements to solve his space science issues with JPL.[140,141] Instead, he asked Clark to convert the existing NASA *Policies and Procedures on Space Flight Experiments* * into a formal NASA Technical Management Instruction, TMI 37-1-1, that would specify the process by which NASA would select space scientists and identify the roles and responsibilities of Headquarters and the centers in that process. Clark designed the process so that it could be applied to the selection of scientists for Goddard as well as JPL missions. Stoller helped Clark draft the document to include the selection of space application as well as space science experiments.[142]

With the lengthy title *Establishment and Conduct of Space Sciences Program —Selection of Scientific Experiments*, TMI 37-1-1 became the equivalent of the Ten Commandments for space science. After a thorough review the Administrator of NASA approved it on April 15, 1960.[143] It clearly built on, but substantially modified, the original policies and procedures approved by Glennan in December 1958 and Silverstein's letter to JPL of January 26, 1960. It entered NASA jargon as "37-1-1," pronounced "thirty-seven-one-one." Every one at Headquarters soon learned that if you didn't do it according to old thirty-seven-one-one, you didn't do it right.

TMI 37-1-1 specified that the director of space flight programs retained final approval of experiments, experimenters, and specific flight missions. He was to appoint the members of a Space Sciences Steering Committee and its six scientific subcommittees. The assistant director of a program office managed the selection process for the missions in his program. Scientists were to send their proposals to participate in a mission to the program office responsible for that mission. After receiving the proposals, the assistant director was to send copies of each proposal, simultaneously, to the appropriate scientific subcommittees and to the field center responsible for the mission. The subcommittees would evaluate the relative scientific

* Originally prepared by Clark and approved by T. Keith Glennan on December 15, 1958.

merits of the proposals while the field center evaluated the technical feasibility and compatibility of the proposed instruments with the spacecraft. The program office would then use the recommendations of the subcommittees and the center to formulate a tentative payload for the mission. The assistant director and his chief scientist then presented, and defended, the proposed scientists and their experiments before the Space Science Steering Committee.

The Space Science Steering Committee, although similar to the steering group proposed in Silverstein's letter of January 26, differed from it in several ways. Newell remained chairman but the committee would consist of only four members, all from Headquarters: the assistant director and the chief scientist for Lunar and Planetary Programs and the assistant director and the chief scientist for the Satellite and Sounding Rocket Programs. Under 37–1–1, the Steering Committee became the focus of all space science and space applications activities. It reviewed and recommended to the director of Space Flight Programs all space science programs, missions, experiments, and experimenters. As engineers and program directors, Cortright and Stoller reviewed and resolved the technical and programmatic issues. As scientists, Schilling and Clark reviewed and resolved the scientific issues. The Steering Committee was to be a permanent organization that met weekly. It has functioned continuously since its inception.

Six scientific subcommittees replaced the single "NASA Committee on Lunar Planetary and Interplanetary Science," referred to in Silverstein's letter. These subcommittees made their recommendations directly, and at the same time, to the Steering Committee and to the program directors. The subcommittees formulated long-range plans for their disciplines, evaluated proposals, and recommended space scientists for specific missions. The TMI did not specify the membership of the subcommittees, only that the director of the Space Flight Program was to appoint the members. In practice, a scientist from NASA Headquarters would chair each subcommittee and each subcommittee would have three kinds of members: space scientists from JPL and GSFC; consultants, who were space scientists from universities; and liaison members, who came from the other NASA centers that were not involved directly in space science flight projects. Newell and his staff selected the scientists and consultants on the basis of their scientific competence and recommended their appointment to Silverstein. The subcommittees met four to six times a year and members served two-year terms.

There were to be four "discipline" subcommittees: Aeronomy, Astronomy and Solar Physics, Ionospheric Physics, and Energetic Particles; and two "Scientific Program" committees: Lunar Sciences and Planetary and Interplanetary Sciences. Each discipline subcommittee was to plan its own scientific program, evaluate the scientific proposals in its discipline, and recommend the space scientists to be selected. They were to evaluate proposals for planetary probes as well as for earth satellites. The two "program" committees were to establish scientific objectives for, and evaluate proposals for, only missions of the Lunar and Planetary Program. This arbitrary distinction between discipline and program subcommittees was deliberate. In February 1960, it was impossible to decide which would work better without trying them both; in addition, Cortright, the assistant director for Lunar and Planetary Programs, preferred to work with program committees, whereas Stoller and Clark preferred to work with discipline committees. Two years later, when he became associate administrator of space science, Newell reorganized the subcommittees and eliminated the program committees in favor of additional discipline committees.

Initially, only two field centers, GSFC and JPL, were to be involved in the space science program. Over the next two decades, however, NASA would assign space science missions to all of the centers except the Kennedy Space Center and the Lewis Research Center. At the centers, a project team was to review each proposal to determine if the instrument was compatible with the spacecraft and if the scientist and his or her team were capable of producing the instrument. After the scientists were selected, the project manager was to establish the schedules for scientists to deliver prototype models of their experiments. This first version of TMI 37–1–1 gave field centers two options for handling the fabrication of the flight models: they could either fabricate the instruments for their mission or they could ask each scientist to fabricate his or her instrument and deliver a flight-ready model to the center. Allowing these two options represented a compromise between JPL and GSFC project-management philosophy. JPL insisted on the right to determine who fabricated the instruments flown on their spacecraft. GSFC insisted that experimenters fabricate their own instruments. With the assistance of the experimenters, each center's project team was to test the flight instruments and integrate them into the spacecraft.

Any scientist, except a scientist working at NASA Headquarters, could propose an experiment for a NASA scientific mission. After the selection process was completed, NASA Headquarters would send a letter to all scientists who had submitted proposals that told them of the results of the process. The letter that went to those who had been selected informed them of their selection, specified the conditions under which their experiment had been selected, told them that the field center responsible for the mission would contact them to arrange a contract for their work. The letter also, specifically invited them to bring any unresolved issues they had with the center directly to Headquarters. At the same time, Headquarters sent a letter, via the center director, to the project manager that informed him of the results of the selection process and directed him to negotiate contracts with the scientists to build their instruments. As a result, experimenters on a NASA space science mission always had two contracts: one with NASA Headquarters based on their original proposal and the NASA letter of acceptance, to accomplish the scientific objectives of their experiments, and one with the field center, to produce the instrument, analyze the data, and publish the results. After receiving their contract from the center, the scientists built prototype models of their instruments and either built or cooperated in the fabrication of the actual flight instruments, analyzed the data, and published the results.

TMI 37–1–1 proved to be an exceedingly important document for NASA and for space scientists. For the first time, it specified the process NASA would use to select space scientists for its scientific missions and delineated a scientist's rights and responsibilities during those missions. It covered the entire life of a mission, from the time scientists submitted their proposals through the time they published their final results.

The first version of TMI 37–1–1 did not require experimenters to produce the flight model of their experiment, nor did it make any provision for informing academic scientists of opportunities to propose experiments for NASA missions. These two provisions were added later. The lack of information about NASA's plans and procedures seriously hampered academic scientists. In addition to all the uncertainty associated with the selection process itself, academic scientists had to live with the uncertainty as to what missions NASA was planning and when it would make its next selection of space scientists. A NASA scientist could easily obtain a year's head start over an academic scientist in a competition because he or she participated in planning the mission. As these flaws and omissions became apparent, NASA modified TMI 37–1–1.

Although TMI 37–1–1 appeared long, cumbersome, and unlikely to work, it was necessary because performing a scientific experiment in space was a long, complex, difficult, and costly process. Unlike some of their colleagues, space scientists could not conceive of experiments on Sunday afternoon as they sat on their patios sipping a scotch and soda, go into their laboratories on Monday, build the apparatus, take data a month later, and send off a paper to the *Physical Review* before the year was out. If they pondered a question on their patio, they had to figure out how to build an apparatus that could survive the stress of a rocket launch, operate unattended for months or years, and accurately transmit the data necessary to answer the original scientific question. In the early 1960s, it could easily take two to five years from the concept of an experiment to a published paper. In 1960, two years seemed an eternity to restless scientists. By the late 1970s, the same process would take one to two decades!

Viewed after several decades of experience, this first version of TMI 37–1–1 had some flaws, mostly in the form of omissions, but it was basically a sound document. It laid a heavy burden of paperwork on the scientists and the field centers. However, it gave everyone, NASA Headquarters, the scientists, JPL and Goddard, and the contractors a road map to follow into an uncertain future. It was a documented process. Omissions or faulty portions could be recognized and corrected.

In February of 1960, Newell had no particular reason to assume that his new organization and his new process for selecting scientists would work any better than his previous arrangement. In order to make it work he still had to recruit and retain competent scientists at Headquarters. He had no reason to assume that competent outside scientists would serve on the subcommittees to evaluate proposals or that scientists would accept the evaluation of their proposals by the subcommittees. He could not be certain that it would be accepted by his NASA colleagues at NASA Headquarters; many former NACA engineers resisted involving academic scientists in any way in the making of NASA decisions.

The Space Science Steering Committee

The SSSC in Action

Newell called the first meeting of the Space Sciences Steering Committee on February 16, 1960, two months before Glennan would approve TMI 37–1–1.[144] The Committee reviewed and unanimously recommended approval of seven experiments to be flown on a mission to test a Ranger spacecraft on a flight past the Moon. Three of the proposed experiments came from universities: a "Photoconductive Particle Detector" from the State University of Iowa, a "Coincidence Detector" from the University of Chicago, and an "Ion Chamber" from the California Institute of Technology. Three came from government laboratories: a "Magnetometer" and a "Micrometeorite Detector" from Goddard and a "Lyman Alpha Scanner" from the Naval Research Laboratory. One, a "Solar Corpuscular Detector," was proposed by a scientist from JPL.

The Committee considered this action a preliminary determination of the payload and recommended that Silverstein authorize JPL to select a final payload from this list after JPL had completed the design of the spacecraft and the scientists had completed the design of their instruments. It is not surprising that the JPL engineers needed additional time to design the spacecraft. They had not commenced their work on this spacecraft until after Newell's December 28 meeting.

The minutes of this first meeting of the Steering Committee illuminate the thinking of Newell and his staff in February 1960. According to the minutes, the Steering Committee recommended the solar corpuscular detector proposed by JPL over two similar experiments, one proposed by the Ames Research Center and one by the Massachusetts Institute of Technology, because these two institutions already had instruments scheduled for flight on Goddard missions. The minutes read: "Scientific data analysis is preferably done by various scientists to improve quality of effort and to avoid saturation of any one group." No mention is made of the scientist for this experiment.

According to the minutes, the Iowa experiment was selected because (1) it had no permanent magnet to interfere with the magnetometer; (2) a year earlier, Schilling had encouraged Van Allen to fly an experiment on one of the ill-fated Vega test missions; and (3) because Van Allen was "an experimenter with internationally proven competence and ability with regard to instrumentation as well as creative ability for imaginative data interpretation." Apparently, the Committee members were concerned about the ability of the Goddard scientist to build his magnetometer experiment in time. They requested that "GSFC management provide formal assurance to JPL that the magnetometer would be delivered on time."

The Committee chose an experiment proposed by Dr. John A. Simpson of the University of Chicago over a similar experiment proposed by Dr. Frank B. McDonald from Goddard, because it complemented the rest of the instrumentation, covered a broader range of particle energies, and provided specific overlap with Van Allen's experiment. In addition, Simpson, under a $300,280 contract with NASA for the past year, was not yet scheduled for a flight on any NASA missions. Schilling had also encouraged Simpson to propose an experiment for the Vega test missions.

The rationale used for the selection of these seven experiments, as recorded by the secretary of the Steering Committee and approved by Newell, was a curious mixture of technical, scientific, financial, and political considerations.

From this rather shaky and uncertain beginning, the Committee proceeded to a second meeting on March 4, 1960.[145] In the interim, Cortright visited JPL and reported that the payload recommended at the previous meeting "appeared to be stabilizing." The Goddard magnetometer experiment and a micrometeorite experiment would be included, and an electric field experiment excluded. The Committee agreed to meet weekly at 9:00 a.m. on Thursdays.

Dr. Pickering, director of JPL, joined the Committee at its fourth meeting on March 16 to discuss the Committee and its subcommittees. He had not yet read TMI 37–1–1 and asked to be excused from comment until later. He questioned the relationship between the Steering Committee and the Space Science Board and was told by Newell that the two were complementary; the Board

> must paint the picture of the science with broad brush strokes. The Steering Committee, which is concerned with the overall view, must concern itself also with the problems involved in actual scientific flights, such as availability and use of vehicles, payloads, balance between the several scientific disciplines in the scientific program and similar, what may be called "practical problems" of carrying out scientific research.[146]

Pickering inquired about the subcommittees and Dr. Newell [147] emphasized that

> NASA desires to use its space vehicles as a national resource, and not to discriminate against any portion of the scientific community in their use. Consequently all decisions for use of the vehicles must be made at the Headquarters of NASA. However, the initiative for scientific experiments must come from the scientific community at large, whether from the research centers or elsewhere; and the initiative for proper packaging of experiments must come from the research centers. The subcommittees can be expected to be continuously in touch with the respective scientific fields of their interest. Their function will be advisory, to inform the Steering committee of their findings and opinions.

Pickering returned to JPL, read 37–1–1, and wrote Newell on March 22. In his letter, he agreed that the duties of the Steering Committee "seem to us to be characteristic of a reasonable and necessary Headquarter's role in this area." He pointed out that the individuals involved in the Steering Committee already reported to Newell and questioned the need to complicate the situation by forming the Committee. Pickering opposed the formation of the subcommittees, stating [148]

> We do not feel that such subcommittees would effectively serve the purpose for which they are intended. We feel that committees organized in this manner that report directly to NASA Headquarters are in danger of losing contact with many problems of the program. As a result, the recommendations of such subcommittees acquire the label "impractical," and become easy targets for those who feel that the scientific objectives of the space program should take on a secondary or tertiary priority position.

Pickering proposed that

> instead of using the subcommittees, the Committee obtain the information necessary for its functions from the JPL and GSFC, authorizing these Centers to organize their own scientific groups to the extent that they find necessary to assist them in preparing reports and study documents for their own use and for forwarding to the Steering Committee.

Pickering endorsed most of the remainder of TMI 37–1–1 except for the section on contracting with universities. Here he felt that no distinction should be made between NASA contracts with universities and those with industry.

Harry Goett, director of Goddard, met with the Steering Committee at its next meeting. Goett thought the Steering Committee was a good idea but he had some reservations. He opposed the use of consultants on the subcommittees. If they were used, he insisted that they not make decisions. Goett wanted preferential treatment for NASA scientists. Many of the NASA scientists, he said, "were working at lower salaries than could be obtained outside of government employment." These people needed extra incentive and inducement to keep them happy and in government employment. The best way to do this was to encourage them in their work and facilitate in every way possible their frequent participation in space experimentation.[149]

Neither Dr. Pickering's letter nor Harry Goett's appearance before the Steering Committee changed Headquarter's views or altered the draft version of TMI 37–1–1. On April 4, at the eighth meeting of the Steering Committee, Newell announced that Silverstein and Dryden had approved the document.[150] Subsequently, Dr. Glennan approved it and on April 15, 1960, NASA officially issued TMI 37–1–1.

As in most situations where strong-minded people with common objectives use different approaches to reach those objectives, the problems between NASA Headquarters and JPL and between NASA and the academic scientists were resolved by negotiation and compromise. No one got everything he wanted out of the negotiations but each achieved at least the minimum he felt he needed to proceed. At JPL, Pickering and his staff did not get the right to select the scientists for their missions but retained most of their control over flight instruments. This control, they felt, was needed in order to ensure success of the lunar missions. Academic scientists did not retain the right to have their own mechanism, the Space Science Board, evaluate their proposals, but the selection was taken out of the hands of their competitors at Goddard. The scientists at Goddard did not retain the right to choose scientists or even to have a privileged position in the selection process, but they got firm recognition of their right to compete on equal terms with academic scientists and were not required to support the work of their academic colleagues, as had been proposed by the Space Science Board. Headquarters took upon itself the right and the responsibility for selecting the scientists for NASA's space science missions.

A Conflict of Interest in the SSSC

One of the principal reasons that NASA Headquarters assumed the responsibility for selecting space scientists was that the scientists at Headquarters who reviewed proposals were expected to be scientific administrators, free of any direct scientific or financial interest in the fate of any proposals they reviewed. As permanent members of the Headquarter's staff, they were no longer to be involved in their own research.

In December 1960, a controversy arose in the Steering Committee when one of the members reviewed and recommended approval of his own experiment.[151] This incensed other scientists at NASA Headquarters, particularly Dr. John F. Clark, who had given up research in order to help administer the national program. Here was a clear case of someone violating the whole idea of maintaining a scientific staff at Headquarters free of any scientific conflict of interest. Not only was this person engaged in research in direct competition with other scientists, but he had sat in judgment of, and been party to, the selection of his own experiment.

The issue was raised at the next meeting of the Committee. Although the Steering Committee did not reverse its recommendation, the incident further clarified the role of scientists at Headquarters, the minutes read [152]

> While it was generally agreed that it is desirable for Headquarters personnel to keep abreast of science, the question of the extent and character of the participation is not as clear-cut. The discussion can be summarized by stating that it was the consensus of the Committee that Headquarter's personnel must not get into the position of being a competitor with scientific investigators supported by NASA.

As a result of this squabble, NASA, in effect, added a new principle to the selection process: Scientists at NASA Headquarters, whose responsibilities included the recommendation of scientists for scientific missions, must not conduct research programs that competed with those of the scientists whose proposals they were evaluating.

This was the last time a member of the Steering Committee sat in judgment on his own experiment. It also marked the end of a long tradition in which chairmen and committee members reviewed and recommended acceptance of their own proposals. This tradition was established by the Upper Atmosphere Rocket Research Panel, continued by the group that selected the experiments for the IGY satellites, and the committees of the Space Science Board, and followed by Goddard project scientists until NASA enacted 37–1–1.

Summary of the Early Work of the SSSC

The Steering Committee met forty-six times in 1960 and at almost every meeting it reviewed and recommended the space scientists for a NASA scientific mission or else established substantial policy guidelines. The Committee created policies and procedures that are still being followed today. There is no record that Silverstein rejected any recommendations of the Steering Committee, so the Committee rapidly became the final step in the process of selecting space scientists. Early in 1960, the Committee reviewed and recommended approval of many missions already underway, providing an after-the-fact blessing and legitimacy to the scientists who had been selected before formation of the Steering Committee.

The Subcommittees of the SSSC

It rapidly became apparent that technical subcommittees were needed to advise the Committee. The minutes of the ninth meeting of the Steering Committee record a discussion of a letter from Dr. Rossi of MIT.[153] Dr. Rossi wrote that research in plasmas was inadequate and that he was having trouble finding missions on which to fly the MIT plasma probes. The Committee decided that Rossi should be invited to the second meeting of the Particles and Fields Subcommittee (which was not yet formed) and discuss his problems.

Goddard management requested permission to establish representative payloads for the first Eccentric Orbiting and Polar Orbiting Geophysical Observatories (EGO and POGO). After discussion in the Steering Committee, Newell requested that four of the subcommittees (Aeronomy, Ionospheric Physics, Particles and Fields, and Astronomy and Solar Physics) recommend experiments for these missions.

At the thirteenth meeting of the Committee, a Goddard memorandum raised two questions. One was related to the relative merits of an alkali vapor magnetometer, a complex, costly, but very sensitive instrument, and a spinning coil magnetometer, a simple, less costly, and less sensitive instrument. The other question related to the use of magnetometers on lunar missions. Newell referred the question of the merits of the two magnetometers to the Particles and Fields Subcommittee and the value of magnetometers on lunar missions to the Lunar Science Subcommittee.

It was obvious that the Steering Committee needed a technical arm to help with its work and the subcommittees would have to fulfill that function.

Once Glennan approved 37–1–1, Newell moved briskly to bring these subcommittees into being.[154] He established six subcommittees and appointed their chairpersons:

Aeronomy, Dr. Morris Tepper
Astronomy and Solar Physics, Dr. Nancy Roman
Ionospheric Physics, Dr. John F. Clark
Lunar Sciences, Dr. Robert Jastrow
Particles and Fields, Dr. John E. Naugle
Planetary and Interplanetary Science, Dr. Homer E. Newell

As yet, Newell did not have enough scientists at Headquarters to go around so he chaired one committee himself and, despite the objections of Pickering and the agreements reached at the December 28 meeting at JPL, he retained Jastrow as the temporary chairman of the Lunar Sciences Committee.

On April 12, 1960, Newell met with the chairpersons, described their responsibilities, and urged them to promptly schedule a meeting with NASA members only, no consultants. He asked the chairpersons to prepare material appropriate to their disciplines for the NASA ten-year plan, to bring the existing short-range plan up to date, and to develop good communications with the scientists in their disciplines. Newell did not discuss the role of the subcommittees in the selection of space scientists.

He requested that each subcommittee recommend four or five consultants, who would be reviewed by the Steering Committee and approved by Silverstein. They could be members of the Space Science Board and its committees. They needed security clearances because NASA launch-related information and dates were classified.

Newell wanted free and full communication between the members of the Steering Committee and the subcommittees; he made all members of the Steering Committee ex-officio members of all subcommittees; and all reports and minutes of the subcommittees were automatically sent to all members of the Steering Committee and to all members of all the other subcommittees. In turn, the minutes of the Steering Committee were sent to the chairpersons of the subcommittees. Newell insisted on a free flow of information between the scientific community and NASA Headquarters. Later, by personally responding in writing to each subcommittee's recommendation and by attending subcommittee meetings, Newell got the message across that NASA took the work of the subcommittees very seriously.

As requested, the subcommittees first met with only the NASA members present. Newell joined each subcommittee, described the role of the Steering Committee, and reiterated the requests he made earlier to the chairpersons. From this time on, a large measure of the success of Newell's new process depended upon the subcommittees and their chairpersons. If they performed well and gained the confidence of the scientific community and their NASA critics, the process would work, if they did not, or if scientists or persons in NASA's legal or procurement departments complained and overturned Steering Committee recommendations, the whole process might collapse.

The Particles and Fields Subcommittee

All of the six scientific subcommittees were formed in the same way and had similar problems getting started. The early activity of the Fields and Particles Subcommittee is typical of the activity of the other subcommittees.

A Shaky Start

On April 1, 1960, the newly appointed chairman of the Fields and Particles Subcommittee sent a memo to Newell that outlined his plans for the Subcommittee.[155] He proposed that the responsibility of the Subcommittee be "the study of charged and neutral radiation of energy greater than thermal and the magnetic fields of the Sun, planets, and space." In addition, he proposed to formulate a long-range program to obtain the necessary experimental data and theoretical work to describe, understand and predict the behavior of the particles and fields in space. Because the phenomena were linked to the eleven-year solar cycle and because the length of the missions required to obtain the data, he proposed to plan a program that extended over at least the next ten years. He stated that he planned to maintain a continuing review of the progress of the program, the status of proposed experiments, and the amount of payload space available for experiments. He proposed that the Subcommittee review proposals and recommend experimenters and experiments to the Steering Committee. The Subcommittee was to consist of a chairman and an executive secretary from Headquarters, five scientists from NASA centers and five from universities. These scientists were to be a mixture of senior scientists and young scientists fresh out of graduate school. Three of the proposed academic scientists were members of the Space Science Board.

Newell approved the proposed membership and granted the chairman a "hunting license" to operate in all the scientific areas that he had proposed. Some of the areas proposed for the Fields and Particles Subcommittee overlapped those of the Ionospheric Physics and the Planetary and Interplanetary subcommittees.

The Particles and Fields Subcommittee met for the first time on May 3, 1960 in the Dolley Madison House.[156] Newell attended and told the group to look for "weaknesses in subject matter, participation, instrumentation development, and supporting research." He requested a ten-year plan by June 15 in order to include it in the annual revision of NASA's ten-year plan scheduled to be printed on July 1. He asked the Subcommittee to provide a perspective of the particles and fields discipline within the NASA space science program. In addition, he urged the Subcommittee to develop good working relationships and sound communications with the scientific community.

The Subcommittee at this time consisted of the following members:

John E. Naugle, chairman, NASA Headquarters
Robert F. Fellows, secretary, NASA Headquarters
Michael Bader, Plasma Physics, Ames Research Center
Joseph C. Cain, physicist, Magnetic Fields, GSFC
Frank B. McDonald, cosmic-ray physicist, GSFC
William S. McDonald, cosmic-ray physicist, JPL
Marcia Neugebauer, plasma physicist, JPL

and liaison members:

J. W. Blue, reactor physicist, Lewis Research Center
Clinton E. Brown, Aerodynamics, Langley Research Center
R. D. Shelton, Nuclear Propulsion, MSFC

The first meeting of the Particles and Fields Subcommittee was singularly unimpressive. Only the chairman, the secretary, three of the five members, and one liaison member attended. After Newell left, the members held a short desultory discussion. They went over the qualifications of the university scientists under consideration for membership and proposed some additional names for consideration, reviewed the concept of the Eccentric Orbiting Geophysical Observatory (EGO), and agreed to prepare a tentative payload for the first EGO at their next meeting. They expanded their purview to include gamma-ray measurements reasoning that gamma rays and cosmic rays used similar instrumentation and that any gamma-ray data obtained would aid in understanding the origin and method of acceleration of cosmic rays. By including gamma rays in their purview, they now overlapped the work of the Astronomy Subcommittee.

An objective observer might have dismissed the whole business as a waste of time and a poor duplication of the work of Committee 8 of the Space Science Board—the Committee on the Physics of Fields and Particles in Space. The chairman had several worries and was unsure of his ability to act as a chairman. He feared his former colleagues at Goddard would be hostile to the concept of Headquarters selecting scientists and was not sure that they would be able to "find the time" to work on the Subcommittee. He feared that academic scientists would refuse to participate because the NASA subcommittee duplicated the Space Science Board's committee. Worst of all, if NASA Headquarters ignored the recommendations of the committee, the pain involved in giving up his personal research and all the time and energy to get the subcommittee started would be for naught.

Business Picks Up

Business picked up at the second meeting.[157] Four of the five members attended, the chairman reviewed NASA's existing Particles and Fields Program, and the group discussed the merits of various magnetometers. The Subcommittee then tackled a thorny issue. Should NASA fly classified DOD experiments on its scientific missions? Scientists from Los Alamos had proposed flying some classified experiments to detect nuclear explosions on JPL's Ranger missions. The Subcommittee voted not to carry classified experiments on NASA vehicles and to evaluate unclassified DOD experiments on the basis of their scientific merit rather than their military significance. The Committee reasoned that experiments with high military significance should qualify for space on DOD missions and not take up precious space on NASA's limited number of scientific missions.

An Appendix, "The Present NASA Particles and Fields Program," was included with the minutes of the second meeting. It listed the complete program, gave the name of each mission, the NASA number(s), the launch vehicle, expected launch date, trajectory, lifetime, project manager, project scientist, the names of the scientists, and a description of their instruments and the institution with which they were affiliated. The list included the purpose of each experiment; the principal experimental parameters to be measured, such as the types of particles or fields to be detected, energy ranges, and types of detectors; a brief description of the experimental arrangement; and the volume, weight and power requirements. In addition to the list of space missions there was a list of planned balloon flights, sounding rockets, satellites, space probes, and planetary missions.

The Appendix was a useful compendium for scientists working in the field and made the members of the Subcommittee instant authorities on the NASA program. This enhanced their status among their colleagues and made membership on the Subcommittee more attractive. The Appendix was also a harbinger of the coming age of bureaucracy in the space science program. No longer would physicists be able to merely conceive of an experiment. In the future, they must specify precisely, and extend as far as possible, the operating range of their instruments. Otherwise, the Subcommittee might select a competitor simply because his or her instrument covered a slightly greater energy range. Such a decision by the Subcommittee would not necessarily be capricious; it might be the only rationale the Subcommittee could find for deciding between two highly competent scientists proposing nearly identical experiments.

The Subcommittee recommended a list of EGO experiments, satisfying the commitment it had made at the first meeting. It recognized a lack of polar satellites in the Particles and Fields Program and recommended a polar radiation satellite. The members discussed radiation damage to solar cells and the use of shielding to increase their lifetimes in the radiation belts.

Newell joined the group to discuss the list of potential university scientists to be added to the Subcommittee. As a result of the discussion, the members modified the list in order to involve more universities, provide better geographic coverage, and increase the number of theoretical physicists.

The minutes of this meeting provide a glimmer of hope that the Subcommittee would succeed and be useful. It gave solid recommendations to senior NASA management and provided clear communications between NASA management and its members. NASA accepted the Subcommittee's recommendations regarding the treatment of experiments proposed by DOD laboratories.[158] NASA did not fly the classified experiments on the Ranger missions, but because of schedule and weight problems, not because of the Subcommittee's recommendation. In the spring of 1960, subcommittee recommendations did not yet carry that much weight.

Background of the Members

On July 11, 1960, the Subcommittee finally assembled in its full glory for a third meeting, with all the NASA members (or their representatives) and four of the five consultants present.[159] By this time, the full membership of the Subcommittee consisted of the following:

Members

John E. Naugle, chairman, NASA Headquarters
Robert F. Fellows, secretary, NASA Headquarters
Michael Bader, Plasma Physics, Ames Research Center
Joseph C. Cain, physicist, Magnetic Fields, GSFC
Frank B. McDonald, cosmic-ray physicist, GSFC
William S. McDonald, cosmic-ray physicist, JPL
Marcia Neugebauer, plasma physicist, JPL

Consultants

Kinsey Anderson, magnetospheric physicist, Berkeley
Thomas Gold, astrophysicist, Cornell University
Eugene N. Parker, theoretical physicist, Chicago
Bruno Rossi, plasma physicist, MIT, Member SSB

James A. Van Allen, physicist, Iowa, Member SSB
John R. Winckler, physicist, Minnesota

Liaison Members

John W. Blue, reactor physicist, Lewis Research Center
Clinton E. Brown, Aerodynamics, Langley Research Center
Richard D. Shelton, Nuclear Propulsion, MSFC

The membership of the Particles and Fields Subcommittee was typical of the six subcommittees of the Space Science Steering Committee. The chairman and the secretary were permanent members of Newell's staff at NASA Headquarters; five scientists came from NASA flight centers and six from universities. Of the six universities represented, two were on the East Coast, one on the West Coast, and three from the Upper Midwest. There was a mixture of Young Turks and wise old heads; six of the scientists were just starting their careers, five were well established.

If membership in the National Academy of Sciences is accepted as a measure of a scientist's ability, the Subcommittee was well qualified. Van Allen and Rossi already belonged to the Academy; Parker was elected in 1967, Gold in 1968, Anderson in 1980, and Frank McDonald in 1986. Van Allen and Rossi were also members of the Space Science Board.

Some of the members of the Particles and Fields Subcommittee shared a unique background. Naugle, Frank McDonald, Anderson, and Winckler were either professors at or had received their Ph.D.s from the University of Minnesota and had conducted cosmic-ray research using balloons in projects funded by the Office of Naval Research (ONR); Anderson, Frank McDonald, and Van Allen had worked together at the University of Iowa using balloons and sounding rockets in projects sponsored by ONR; William McDonald worked at ONR prior to joining JPL. Six members, Naugle, Frank McDonald, Anderson, Winckler, Parker, and Van Allen, were members of the Midwest Cosmic Ray Conference that met in mid-winter in Minneapolis, Chicago, or Iowa City, presented informal papers, quarreled over results, and consumed a good deal of food and liquor. Although called a conference, it was actually a series of symposia in the classic Grek sense.

Clearly, most of the members of the Fields and Particles Subcommittee shared a common professional heritage and scientific philosophy. Prior to Sputnik they were watched over and supported by an enlightened and benevolent Office of Naval Research (ONR), which expected them to conduct original research in cosmic rays and publish their findings in reputable, refereed, scientific journals. When academic scientists visited ONR to discuss proposed cosmic-ray research projects, they expected to meet with an ONR employee, usually another scientist, who understood the objectives of the proposed research project and was sympathetic to the problems of conducting research in a university. After such a meeting, the scientists sent their proposals to ONR. ONR then sent them to other scientists working in the same field of research for review and comment. The scientists who administered the ONR programs used the comments they received from the reviewers and their own scientific judgment to decide whether to fund the proposed research. Academic scientists expected the scientists at ONR, and the proposal reviewers, to respect and protect their proprietary ideas and discoveries. The members of the Particles and Fields Subcommittee approached their work with this same professional philosophy.

No Substitutes, Please

Two of the absent members sent representatives to the third meeting. Their representatives were not allowed to participate in the meeting because they were there in direct violation of Newell's policy—the members and consultants were chosen on the basis of their scientific competence and not as representatives of their institutions. If a member of the Subcommittee could not attend, then his or her seat at the Subcommittee table was vacant. This policy provided an added incentive for the members and consultants to attend; if they failed to appear, their views and their area of research would not be represented.

By this time, membership on a subcommittee was becoming distinctly attractive to NASA and to academic scientists. Members of subcommittees became aware of the entire NASA program in their discipline. They influenced the NASA program and spoke with authority to their staff and colleagues. Other scientists not on the subcommittee called them to find out what new missions NASA was considering and to suggest actions that NASA should take. Their position on the subcommittee increased their prestige among their associates and added to the clout they had at their own institutions. Active participation in subcommittee activity became more attractive.

At this third meeting, the Subcommittee reviewed NASA's 10-Year Plan for Energetic Particles and Fields. Frank McDonald reviewed the status of the Orbiting Geophysical Observatories (OGOs), and the Energetic Particles Satellite, Explorer XII. Marcia Neugebauer reviewed the status of Rangers I and II.

The group held a long discussion about interplanetary plasma—the thin, highly ionized gas that pervades space—and decided that the lack of plasma data was one of the greatest stumbling blocks in the understanding of interplanetary space. It also concluded that one of the major difficulties in performing plasma measurements was the uncertainty over the electrostatic charge on the vehicle. Members recommended the formation of a group to study the problem and to recommend to the Subcommittee a satellite design that would minimize the effects of the vehicle charge on plasma measurements.

Genesis of the "AFO"

During a lengthy discussion of NASA's communications with the scientific community, the academic scientists raised a question: how did NASA plan to inform academic scientists of available payload space on NASA missions and the schedule for allocating it? Scientists needed this information to plan their own research programs and to decide the NASA missions for which they would go to the effort required to prepare proposals. The Subcommittee recommended that NASA announce its plans for new missions in scientific journals and magazines and give the name and address of the person at NASA who was in charge of a mission. The Subcommittee also recommended that NASA publish pertinent details of missions in a document and send it to all scientists with NASA contracts and to all other scientists interested in space science. The document would specify the number of copies of proposals required and the date they should reach NASA to be considered for a particular mission, and the scientists would be asked to respond with formal proposals with funding requirements and sufficient data to enable the Subcommittees to evaluate their scientific merit. The Subcommittee also recommended that the proposals contain sufficient information on the weight, volume, power, and special structural requirements to enable the field center responsible for the mission to determine if the experiment was compatible with the spacecraft.[160]

Here was a significant set of recommendations. Not only should payload space on NASA vehicles be available to all scientists but every effort should be made to ensure that every scientist, whether at a university or a NASA center, would have equal access to the information about a mission and an equal chance in the competition. Ultimately, this recommendation made its way into later versions of TMI 37-1-1 and NASA began to issue "Announcement of Flight Opportunities" or in the jargon of the space scientist, "AFO's."

The Selection Process Bypasses the Subcommittee

It was the fall of 1961 before the Subcommittee participated in the selection process. The fields and particles experiments selected for the JPL Ranger missions were not reviewed by the Particles and Fields Subcommittee. The Lunar and Planetary Program Office in NASA Headquarters selected the scientists and sent their names to the Space Science Steering Committee, which reviewed them and forwarded them to Silverstein for his approval. It still behooved aspiring space scientists to maintain good relations with the project scientists at Goddard and JPL as well as with the program scientists at NASA Headquarters if they wanted to fly. (Not until June 1962, at its tenth meeting, did the Particles and Fields Subcommittee review and evaluate a set of competing proposals for a specific mission.)

The Particles and Fields Subcommittee met in May 1961 at JPL, where the members listened to the results of Explorer X, a short-lived, battery-powered spacecraft, instrumented with a magnetometer and plasma probe, that had been launched March 25, 1961, to study the magnetosphere. It also reviewed the status of Ranger 1, which was at the Cape awaiting launch, and the Eccentric Orbiting Geophysical Observatory, whose proposed payload was 150 pounds overweight. In addition, the Subcommittee reviewed, but took no action with respect to, the scientists and experiments selected for Mariner A, the mission scheduled to fly by Venus in 1962; endorsed two new missions, S–64 and S–64a, designed to be flown in geostationary orbits to study the magnetosphere; reiterated the need for a small polar-orbiting radiation satellite; and strongly endorsed another flight of either Explorer XII, or P–14, with several additional experiments to study cosmic rays and the magnetosphere. It also went over the experiments proposed for EGO and made comments with the understanding that it would review the payload before NASA Headquarters made a final selection in the fall.[161]

The next meeting, in Boulder, Colorado, in October combined a meeting of the Particles and Fields Subcommittee with a symposium on solar flares. Sponsoring a symposium or scheduling Subcommittee meetings in conjunction with professional society meetings proved to be good devices to get members to attend.

By setting priorities for the experiments for the Interplanetary Monitoring Probe (IMP) at this meeting, the Subcommittee began to participate more directly in the evaluation and selection procedure. In August 1961, shortly before the Subcommittee meeting, Dr. Leslie W. Meredith and Dr. Frank B. McDonald of Goddard proposed a new mission directly to the Space Sciences Steering Committee. This new mission, the IMP, was designed to place a spacecraft in a highly eccentric orbit traveling from below the radiation belts through the magnetosphere and into interplanetary space. Its objectives were consistent with earlier recommendations of the Space Science Board and the Fields and Particles Subcommittee. It was also needed to monitor the radiation environment in space during the Apollo missions. McDonald's and Meredith's proposal included a group of scientists, selected by McDonald, whose combined experiments were likely to exceed the weight capability of the launch vehicle. The

Subcommittee reviewed the payload and by secret ballot ranked the ten proposed experiments in order of their scientific merit.

McDonald, the IMP project scientist, had selected a logical group of scientists for the mission. The members of the Subcommittee had no quarrel with his selection, even though he had included his own experiment in his recommendation. There had been, however, no official notice to any scientist, including those proposed by McDonald, of the IMP mission and no opportunity for scientists other than those selected by McDonald to participate in the IMP mission. Launched November 27, 1963, IMP-I, or Explorer XVIII, became a spectacular success and the spacecraft series created by McDonald became the workhorse of fields and particles research for the next decade.[162]

The Subcommittee Begins to Evaluate Proposals

The first IMP payload was the last payload selected by a project scientist at Goddard or JPL. After this first IMP, NASA Headquarters advertised each new mission and provided adequate information well in advance of the selection date, so that any scientist, whether in a university or in a NASA center, could compete on an equal footing for a place for his or her experiment.

At its tenth meeting, June 1962, the Particles and Fields Subcommittee settled into the evaluation procedure that it used to review proposals, a procedure it followed until January 1970, when the Subcommittee was abolished. During this meeting the Subcommittee evaluated twenty-six proposals for the first Polar Orbiting Geophysical Observatory (POGO). The chairman grouped proposals with similar scientific objectives together, such as those that measured magnetic fields and before the meeting asked a Subcommittee member who was familiar with a particular area of research to read all the proposals in his or her area. At the Subcommittee meeting, this member presented a personal assessment of the relative scientific and technical merits of the proposals reviewed. All the members of Subcommittee then discussed the merits of all the proposals and placed each of them in one of four categories:

	Scientific Value	Technical Status
Category I	Excellent	Excellent
Category II	Good, but old	Excellent
Category IIIa	Excellent	Uncertain
Category IIIb	Good	Uncertain
Category IV	Not suitable for this mission	

All the members and consultants reviewed and summarized proposals and voted on the category in which an experiment was to be placed. There were two exceptions: No member was asked to review and summarize his or her, or a competitor's, proposal, and each member left the room when his or her own proposals were discussed and categorized. In its work the Subcommittee made no distinction between scientists from NASA centers, from universities, or from other government or industrial laboratories. With the exception of the chairman and secretary, who were from NASA Headquarters, all the members and consultants were scientists actively engaged in space research. They were familiar with the objectives of the experiment, the competence of the scientist, the nature of the instruments proposed and the ability of the scientific team to build them. In the case of the Polar Orbiting Geophysical Observatory (POGO), the Subcommittee placed ten experiments in Category I, one in Category II, one in Category IIIa and fourteen in Category IV.[163]

At the next meeting, on September 6, 1962, at the request of the Lunar and Planetary Program Office, the Subcommittee evaluated eleven proposals for a lunar orbiter. It placed four experiments in Category I, three in IIIA, and the rest in IV. IT also evaluated three experiments for a Goddard satellite to be placed in geostationary orbit, placing one experiment in Category I, one in IIIA, and one in IV.[164]

The Roles of the Subcommittees and the Program Offices

The members of all the subcommittees expected a Headquarters program office to use only Category I experiments to make up a payload and to select a Category II experiment only if no Category I experiment had been proposed. They also expected the program offices to provide funds to scientists whose experiments were placed in Category IIIA so that they could continue to develop their instruments to the point where they could make it into Category I during future evaluations. The subcommittees placed experiments in Category IV either because they were poor experiments or because they were "unsuitable" for the mission under consideration. An experiment might be unsuitable for a variety of reasons. It might weigh too much, require too much telemetry or a different orbit, or it might just be an inferior or shoddy experiment. The official minutes of subcommittee meetings almost always used the word "unsuitable," rather than "shoddy," when placing an experiment in Category IV in order to protect the reputations of scientists at their home institutions.

The members of the subcommittees jealously guarded their roles in the selection of experiments and were very careful in their evaluation and categorization of a scientist's proposal. They recognized that they were not selecting the scientists; they were only choosing the group of scientists from which the program office would select the scientists to participate in the mission. As long as a program office selected only those scientists placed in Category I, the subcommittees had no justification to complain about a selection. The subcommittees recognized that the program office had to take into account the recommendations of other subcommittees as well as the payload space and funding available for instruments.

In 1963, however, despite the existence of a Category I experiment with similar objectives, a program office proposed a payload to the Steering Committee that included an experiment that had been placed in Category III by the subcommittee that had reviewed the proposals. Not only did the program office select a Category III experiment, but it passed over a competing Category I experiment. The chairman of the subcommittee that had reviewed the proposals protested, and in one of the few cases (perhaps the only one) the Steering Committee reversed a recommendation of the program office and recommended the selection of the scientist whose proposal had been placed in Category I. This row effectively settled the roles of the subcommittees and the program offices in the selection of scientists: The program offices would select the scientists for a mission but they had to respect the recommendations of the subcommittee. There were no more instances where a program office selected a scientist whose experiment had been placed in Category II or III if there was another scientist whose experiment had been placed in Category I.[165]

Conflict of Interest in the Subcommittees

From the beginning, Newell and his staff worried about the conflict of interest in using scientists to evaluate their competitors' proposals. NASA created the Steering Committee and its subcommittees at a time when competition for payload space for some disciplines was already fierce. Earlier, the Space Science Board and the President's Science Advisory Committee had severely criticized NASA's selection procedures.[166,167,168] In view of these concerns, Newell and the members of the Space Science Steering Committee concluded that they needed to persuade the most competent and knowledgeable scientists in the field to serve as members of the subcommittees. Such scientists were essential to ensure that only scientists with the best proposals were selected. Competent scientists, however, were usually those participating in the program and regularly submitting proposals of their own for flight, and therefore likely to have a conflict of interest. Nevertheless, Newell concluded that the need to select the best experiments far outweighed the need to avoid the conflict of interest and directed the chairmen to seek the most competent scientists to serve on the subcommittees, regardless of potential conflicts of interest. In order to reduce the adverse effects (real or imagined) of the conflict of interest, Newell required that a subcommittee member whose proposal was under review leave the meeting while his or her experiment was discussed and voted on.

As soon as the subcommittees began evaluating proposals, a new problem arose: How to provide the subcommittee members with adequate information about the scientists and their proposed experiments. Young and inexperienced scientists were entering the field, often with new and untried instruments. Subcommittee members, uncomfortable using only the written proposals in their evaluation, requested their chairmen to invite scientists to come before the subcommittee and argue the merits of their proposals. There was a precedent for this; the chairman of the Working Group on Internal Instrumentation, the group that evaluated the proposals for the Vanguard satellites, had invited anyone proposing an experiment to come before the Group and explain his or her experiment. In this way, scientists could present more detail than they could in their written proposals, answer questions of subcommittee members, and, by their presentation and response to questions, give the members some insight into the competence of the scientists themselves.

Newell agreed to allow subcommittee chairmen to invite scientists to present their proposals, provided all the scientists with similar or competitive proposals were also invited to discuss their proposals with the subcommittees during the same meeting. In cases where the competition was high and subcommittee members had difficulty deciding between rival proposals, a chairman might invite the proponents of competing proposals to come back into the meeting two or three times during the discussion to clear up some misunderstanding about the capability or status of the proposed instrumentation. Thus, in the early 1960s, Newell and his staff made every effort to use the most competent people to evaluate proposals and provide them with the information they needed to make their evaluations, even though this sometimes created a legal or scientific conflict of interest.

The intense competition among scientists and the concern about conflict of interest placed tremendous pressure on the members of the subcommittees to assign only superior experiments to Category I and to understand and be able to justify the subcommittee's decisions. Although scientists at NASA Headquarters made the final selection and subcommittee members were requested to refer all inquiries and complaints about a selection to NASA Headquarters, this still did not protect a subcommittee members from questions about or criticism of their actions on the subcommittee. The names of the members of the subcommittees were well known; a colleague who was not selected could corner a member at a scientific meeting or elsewhere and demand to know why his or her proposal was placed in a low category. The member knew that there had better be a logical rationale for the subcommittee's decision. If the rationale was not logical, one's colleague was likely to consider the member stupid or a liar. If the member used the wrong rationale or tried to blame other members of the committee for the decision, he or she would be in hot water with the other members of the subcommittee and NASA Headquarters.

Subcommittee meetings were often acrimonious. Moreover, program chiefs in NASA Headquarters fought one another over the allocation of payload space for their respective disciplines; academic and government scientists complained they were not getting a fair shake; lawyers and procurement specialists worried about the informality of the procedure and legal conflicts of interest; and disputes sometimes erupted in the Steering Committee. Nevertheless, beginning in 1962, the selection process began to work. The program offices at NASA Headquarters issued AFOs and selected the scientists. NASA's space flight centers awarded contracts, integrated experiments into the spacecraft, and flew the missions. The scientists prepared proposals, built instruments, analyzed data, published papers, and grudgingly accepted the procedures laid down in TMI 37–1–1. Once the Steering Committee reviewed a proposed payload, and the associate administrator for the Office of Space Science approved its recommendation, no disgruntled scientist overturned a selection during the years the subcommittees operated.

Chapter 7

THE IMPACT OF JAMES E. WEBB

Creation of the Office of Space Science

During 1960 and 1961, as Newell and the scientific community developed a mutually satisfactory selection procedure, another worrisome event loomed on the horizon—1960 was an election year. Who would be the new president? What would his attitude be toward space? Who would he appoint as Administrator of NASA? Would the new administrator want a strong space science program or would he focus on manned space flight? Would he want strong university involvement or would he bring the space science program into the NASA field centers? Would he want to clean house and appoint his own people to key positions? As 1960 drew to a close and John F. Kennedy was elected president, these and other questions plagued Newell and his staff. Their concerns were intensified when the appointment of the new NASA administrator dragged on long after most of the other members of the new administration were selected.

Early Misconceptions About Webb

It was January 1961 before Kennedy finally named James E. Webb as NASA administrator. No one in the Office of Space Flight Programs knew much about him; information trickled in that he was a red-neck lawyer and Democratic politician from North Carolina, a former director of the Bureau of the Budget under President Truman, and a former under secretary of state to Dean Atcheson. The scientists in NASA Headquarters thought that this was an inappropriate background for a leader. They wanted someone with a keen interest in space science and strong opinions about the role of the Space Science Board and the involvement of universities in the space program. How wrong they were!!

There came a day in February 1961 when Newell and his staff confronted Jim Webb. That day they discovered that he was indeed a lawyer from North Carolina, had directed the Bureau of the Budget, but was definitely not a red-neck, Democratic politician. Although he was not a scientist, they found that he understood science and scientists; he knew the long-range importance of space science to the nation and most definitely wanted universities to play a major role in the space science program.

When Webb took over in the spring of 1961, NASA had been following the selection process specified in TMI 37-1-1 for almost a year. However, the use of it in the future was by no means certain. The scientific community and many people inside NASA had not yet accepted it. The Space Science Board and its committees were still operating and ready to take on a major role in the selection of space scientists. Webb had several options: he could chose to accept the existing process; he could abolish TMI 37-1-1 and create his own process; he could eliminate Newell's organization and use the Space Science Board to plan the space science program and select the scientists, as it had done for NASA in 1958 and 1959; he could decide that space science was too complex, risky, and important to the national welfare to involve academic scientists and move all of the scientific research into the NASA centers; or he could delegate the responsibility for planning the program and selecting the scientists to the NASA centers, giving the nation a lunar and planetary program formulated and executed by Pickering and his staff at JPL and an earth satellite program formulated and executed by Harry Goett and his staff at Goddard.

Out of all these options, Webb chose to continue with the same basic organization and the existing selection process, with two fundamental and important changes. He strengthened the scientists' control over the selection process and he created the NASA University Program to provide additional research support, facilities, graduate students, and security to academic scientists. Webb's University Program also encouraged the presidents and vice presidents of universities to actively participate in NASA's Space Science Program and to publicly support all of NASA's programs.

Webb wanted a strong, technically competent Headquarters organization and equally strong centers, but centers that would respond, promptly and properly, to direction from NASA Headquarters. He wanted the backing and help of the Space Science Board, but did not want the Board to sit at his elbow and tell him how to run NASA. He wanted a strong university program and the backing of university administrators. He was prepared to provide universities with new laboratories, graduate fellowships, and research grants to encourage them to participate in the space science program.

Webb Creates an Office of Space Science

On November 1, 1961, Webb reorganized NASA Headquarters. He abolished Silverstein's Office of Space Flight Programs and the Office of Launch Vehicle Programs. In their place he created three new offices: the Office of Tracking and Data Acquisition, the Office of Manned Space Flight, and the Office of Space Science. Silverstein left Headquarters to return to the NASA's Lewis Research Center as its Director. Webb appointed Newell as director of the Office of Space Science and Edgar M. Cortright, assistant director of the Lunar and Planetary Program, as Newell's deputy. Webb assigned responsibility for all unmanned launch vehicles to the Office of Space Science and for all manned launch vehicles to the Office of Manned Space Flight. These changes gave Newell control of his transportation to space, one of the tools essential for a successful space science program. However, Webb did not give Newell control of the two space flight centers, one of the tools Newell needed to conduct his program. Instead, Webb took the control of JPL and Goddard, which had resided in the Office of Space Flight, and gave it to the associate administrator, Newell's immediate superior. Two years later, Webb realized his mistake and placed Newell in charge of the two centers, finally giving him all the tools he needed to conduct the program.

Newell then reorganized the Office of Space Science into a launch vehicle division and three scientific divisions: Geophysics and Astronomy, Lunar and Planetary, and Life Sciences. Following the pattern established by Silverstein in 1960, Newell appointed a director and deputy director for each division, making one a scientist and the other an engineer. Newell made one important change. Under Silverstein the director of a division was always an engineer; under Newell, the director could be either a scientist or an engineer, depending upon his or her seniority and leadership ability. If the director was a scientist, then the deputy was an engineer and vice versa. Each division had two kinds of positions: program chiefs, who were scientists, responsible for a particular scientific discipline, and program managers, who were engineers, responsible for a single major scientific mission or several smaller missions. In addition to a program manager, each scientific mission had a program scientist, usually a program chief, who, among other duties, handled the selection of the scientists for that particular mission. Newell also created a position of chief scientist and chairman of the Space Science Steering Committee, a position that he did not immediately fill.

Line management went from Newell to Cortright to the Division directors. The Division directors remained responsible for planning missions, overseeing the selection process, and recommending payloads to the Steering Committee. Newell rewrote TMI 37-1-1 and gave himself final approval authority for all NASA space science experiments.[169,170]

Newell remained chairman of the Space Science Steering Committee throughout the rest of 1961. In the spring of 1962, he found that administrative work occupied too much of his time and appointed Dr. John F. Clark as chief scientist and chairman of the Space Science Steering Committee. This final appointment established the administrative structure for the Office of Space Science at Headquarters that survived for the next two decades.

Shadow Networks

As chief scientist, Clark led a "shadow" scientific network that consisted of the lead scientist (director or deputy) and the program chiefs in each division. Newell's deputy, Cortright, led a similar informal shadow engineering network that consisted of the lead engineer and the program managers. The shadow science network handled the purely scientific issues and the shadow engineering network handled the purely engineering issues. Issues involving both science and engineering and direction to center directors went through the formal line organization. These shadow networks served to speed the routine work, promote teamwork between scientists and engineers, and to make the most efficient use of payload space available on the NASA missions.

Webb's University Program

In June 1961, Webb decided to encourage additional university participation in NASA's space science program and improve the ability of academic scientists to compete for the opportunity to participate in NASA's scientific missions. He directed Newell to conduct a study to see what could be done. Three activities resulted from the study: construction of new laboratories at universities, provision of fellowships for graduate students, and establishment of "step funded" grants for space research. Webb, however, did not provide the regional engineering centers to support academic scientists that the Space Science Board had recommended. Instead, he provided facilities and funding to the universities so that an academic scientist could conduct the research needed to develop an instrument and prepare a proposal for a scientific mission. These Supporting Research and Technology (SR&T) funds also helped the academic scientists to maintain the engineering staff they needed to design, build, test, and integrate their instruments into NASA spacecraft. Scientists at Goddard and JPL already had access to a large group of experienced aerospace engineers. By providing funding for facilities and engineering support to universities, Webb enabled academic scientists to compete on a more equal basis with Goddard and JPL scientists.[171]

The Space Science Board Reorganizes

In the fall of 1961, spurred by discussions with Webb and a letter from Dryden, Berkner reorganized the Space Science Board, abolished most of its committees, and announced his intention to retire as chairman in June 1962. Before he left, he helped the Board start on a new direction. He organized the Board's first summer study to plan a long-range strategy for space science. Berkner turned, once more, to Dr. James A. Van Allen to lead the study.

The study group met in Iowa City, Iowa, for two months in the summer of 1962. The Iowa Summer Study set a pattern for all the studies conducted by the Board over the next twenty-five years wherein each summer the Board reviewed or revised NASA's long-range strategy. The Iowa Study considered the broad objectives and major missions of space science, endorsed some, eliminated others, and postponed others until the science or the technology was ready.[172,173,174] The Board conducted a second study in Woods Hole, Massachusetts in 1964 to help plan a program for NASA after the completion of the Apollo Program. These studies helped NASA conduct a coherent series of major scientific missions such as Viking, HEAO, the Hubble Telescope, Pioneer's X and XI, and Voyager.

Major Conflicts Resolved

Dryden's letter to Berkner in the fall of 1959 had taken the Space Science Board out of the business of selecting space scientists. Webb's reorganization in the fall of 1961 placed Newell in charge of planning and executing the space science program and selecting the scientists to participate in it. The reorganization ended Newell's rivalry with the directors of JPL and Goddard for the right to control the space science program and select space scientists. As a result, in 1962, everyone—academic and NASA scientists, the members of the Board, the directors of Goddard and JPL, and the administrative scientists at NASA Headquarters—could now settle down to do his or her part of the job to ensure that the United States achieved its goal to be leader of the world in space science and technology.

Chapter 8

SUMMARY AND ASSESSMENT

Summary

In the summer of 1958, while a new space agency was forming, the Space Science Board had solicited and evaluated proposals from scientists to participate in the nation's space science program. The Board sent its recommendations to the three agencies that it thought would be involved in space science—the National Science Foundation, the Advanced Research Projects Agency, and the new space agency, the National Aeronautics and Space Administration (NASA). In December 1958, shortly after it opened its doors, NASA established a policy that all scientists, whether in academia, industry, or federal laboratories should have equal opportunity to participate in NASA's Space Science Program and that NASA Headquarters, not the Space Science Board, would decide which scientists would be selected.

By December 1959, however, NASA faced a serious crisis in the selection of space scientists. Many scientists were competing for the limited opportunities to fly their instruments on NASA's spacecraft; NASA had not yet established the procedures to implement its policy or produced a documented process for selecting space scientists; and the Space Science Board had continued to accept and evaluate proposals. By the end of 1959, scientists were confused as to who was selecting space scientists—the Space Science Board, scientists at NASA space flight centers, or scientists at NASA Headquarters.

As a result of this confusion and the lack of a formal selection process, scientists did not trust NASA to provide equitable access to, or make a fair selection from among the proposals of, the competing scientists. Academic scientists were convinced that the scientists at the two NASA space flight centers, the Goddard Space Flight Center and the Jet Propulsion Laboratory, had an advantage because they were heavily involved in planning scientific missions and in the selection of scientists for those missions. Conversely, the scientists at the two NASA centers were convinced that academic scientists had the advantage because the early selections of scientists for NASA missions had been made by the Space Science Board and the Space Science Board consisted only of senior academic scientists. In addition, these scientists at Goddard and JPL, particularly those at Goddard, felt that they did not have an equal opportunity to participate in the missions managed by the other center. They felt that the other center would favor proposals from their own scientists or from senior academic scientists.

Young scientists felt that they did not have a fair chance to compete because the selections were made by senior scientists on selection committees who often evaluated and selected their own proposals, a tradition that had been established in the early sounding rocket programs when there was only a handful of scientists interested in using rockets in their research program. The scientists who selected the scientists for the first satellite experiments had continued this tradition. NASA Headquarters was under extreme pressure from Congress to fly some successful missions and obtain some exciting results in order to demonstrate to a worried public that the United States was once more the leader in space science and technology.

Early in 1960, NASA regained the confidence of the scientists by bringing the selection process into NASA Headquarters and placing it in the hands of scientists who had left active research to become administrators of scientific programs at NASA Headquarters and therefore should have no professional or personal interest in the outcome of the selection process. NASA created the Space Science Steering Committee to review the objectives of each scientific mission, the scientists who had been selected for that missions, and the process that had been used to select them. The Steering Committee created discipline subcommittees to evaluate the technical merits of their proposals and the scientific competence of the competing scientists and categorize each proposal as to its scientific merit and readiness for flight. Each of these subcommittees was chaired by a Headquarters scientist and its membership consisted of active space scientists from academia and the NASA space flight centers. Scientists were prohibited from evaluating their own proposals.

NASA evolved a "fairness" doctrine which combined scientific merit with equitable access to flight opportunities. NASA issued a formal announcement well in advance of the time it planned to select the scientists for a particular mission. This announcement contained the schedule and all necessary technical information. In a further effort to enable academic scientists to compete on an equitable basis with the scientists at the NASA centers, NASA Headquarters provided balloons and sounding rockets as well as funds for supporting research and development that enabled academic scientists to continue to analyze their data from previous missions, train graduate students, develop new instruments, and prepare proposals for the next competition.

NASA documented this process in TMI 37–1–1 and began to apply it rigorously to the selection of space scientists. The NASA process resolved the immediate crisis, established NASA's credibility, and provided sufficient confidence, encouragement, and support to enable over one thousand scientists to participate in the space science program. The basic process instituted in 1960 is still being used today.

Assessment

NASA's Unique Problems

NASA was the first federal agency to confront head-on the perplexing problem of how to select from a large group of highly competent and highly competitive scientists those few who would be allowed to use an expensive, highly visible, publicly furnished scientific facility.

The cost and risk of space science created many difficulties for NASA and its space scientists. By the end of 1959, it was apparent that each space science mission would take about as long to build and cost about as much as a major accelerator or telescope. Once built, however, a ground-based telescope or accelerator could continue to operate for a decade or more, whereas a spacecraft would operate for only a year or two. Scientists depended on ground-based facilities to work for ten or twenty years. Space scientists knew their spacecraft might fail after a year or two and they would receive no more data from the mission. Their space research program was over until they could place their instruments on another NASA mission or unless they could continue their research by using balloons and sounding rockets.

The fierce competition and the risks inherent in space flight, together with the lack of any assured continuity in a scientist's research program, placed extreme pressure on NASA for a commitment to fair competition among scientists.

NASA held a monopoly on U.S. space science. Scientists conducting ground-based research generally had access to several facilities and funding from two or three federal agencies, whereas a space scientist had no recourse but to work with NASA.

NASA operated under the glare of the TV camera. Ordinary people paid extraordinary attention to space activities. Sputnik shocked Americans and turned space research into a race with the Soviets. Exciting races, whether between horses or spacecraft, help sell newspapers and TV time. In addition to the competitive aspect of space, people were full of questions and excited by the newness of space flight and space science, particularly in the areas of lunar and planetary exploration. Were there really canals on Mars? Did a civilization exist under the clouds of Venus? What causes the great red spot on Jupiter? The media understood this intrinsic interest and exploited it. Many scientists found themselves before television cameras explaining the "earth-shaking" significance of their data before they even had time to determine that their instruments were working properly. The media attention helped NASA justify scientific missions to the Bureau of the Budget and Congress, but it made the agency more vulnerable to complaints from dissatisfied scientists.

NASA's Solutions to Its Problems

In order to solve its problems, NASA created a strong Headquarters organization with a scientific and technical staff to establish policy, formulate the research program, establish scientific missions, and select the scientists for those missions. NASA dealt with the intense competition among space scientists and all the congressional and media attention by establishing an elaborate procedure to select space scientists: the formal announcement of opportunity; the subcommittee's scientific and technical evaluation of proposals; the center's determination of compatibility of the instrument with the spacecraft; the preparation of a tentative payload by the program office; the Steering Committee's review of the selection process and the scientists selected—all before final approval by the associate administrator for the Office of Space Science. After approval, the associate administrator sent letters to all who had submitted proposals advising them of the outcome and listing the scientists that he had selected. This lengthy step-by-step process left ample time for dissatisfied scientists to complain and for those complaints to be dealt with prior to final approval. In addition, NASA rigorously followed its own procedures, resisted external pressures and kept scientists informed as to its plans and decisions.

Conflict of Interest

Were the subcommittees "old-boy" networks? Were conflict-of-interest principles violated? Were they fair? Did they do a good job? The subcommittees were certainly "old-boy" networks in the sense that the members were all competent, practicing, highly competitive, space scientists who knew one another well. Conflict-of-interest principles were sometimes violated. Subcommittee members evaluated proposals of other scientists who came from their own institutions, an ethical conflict of interest. Although subcommittee members did not evaluate their own proposals, they evaluated proposals that competed with theirs for space on the same spacecraft.

In practice, however, the subcommittee evaluations were fair. They had to be. The subcommittee members were selected on the basis of demonstrated competence. A subcommittee member knew his or her tenure on the committee was limited; a year or two later, the competitor whose proposal he or she was evaluating might very well be on the committee and evaluating a proposal of the current subcommittee member. Subcommittee members operated in the presence of ten to fifteen of their scientific colleagues; if anyone attempted to favor an obviously inferior proposal of a friend or colleague, that person's colleagues judged him or her stupid or dishonest, and either judgment was likely to damage a scientist's career. Van Allen points out how very difficult it is for scientists to put anything over on their colleagues on an evaluation committee, separately or collectively.[175]

NASA asked the most qualified and most knowledgeable scientists to serve on the subcommittees and many agreed to serve. The intense competition and the scrutiny of their peers forced them to examine competing proposals in great detail in order to understand their strengths and weaknesses and to be able to justify the subcommittees' recommendations. In one sense, the competition made their work easier: they generally had two or three excellent proposals, each prepared by highly competent scientists, so that no matter who they recommended they could be sure they were recommending a first-class scientist with a first-class experiment.

Did NASA evolve a perfect selection process? No. There is no way to assemble a group of scientists with the requisite knowledge and experience to evaluate a group of scientific proposals without, at the same time, assembling their particular prejudices, including their lack of time to carefully read all the proposals and their tendency to follow the herd in making decisions. Some will have to pontificate, thereby using up available time so that the final decisions will be made in haste in the closing hours of the meeting, with half the group gone and the other half eyeing the clock to be sure they catch their plane home. In convening such a group, a compromise will always have to be reached between using the most competent scientists and avoiding conflicts of interest.

Lessons Learned

What lessons can be learned from the NASA experience in selecting space scientists? Which techniques can be applied to other large science programs? Several conclusions can be drawn from the NASA experience:

A scientific research program must be planned and administered by scientists, rather than engineers or professional administrators; only in this way can an agency hope to keep the scientific objectives uppermost in the program. Academic scientists and their graduate students must be involved; they provide new ideas and the new people essential for the long range health of the program. Academic participation helps ensure rapid dissemination of the scientific results into society.

Institutions that operate large research facilities must have a cadre of highly competent scientists to help plan and operate the facility. They are needed to ensure that the facility, whether a telescope or a spacecraft, is built to meet the scientific objectives and does not become merely an engineering marvel. These scientists at the facility must be able to conduct their own research projects. Knowledgeable scientists, who are not in competition for funds or the right to use the facility, should oversee the selection process in order to enable academic scientists and scientists operating the facility to compete on an equitable footing. Both groups of scientists are essential for a sound, creative, long-range research program.

Because of the nature of the space program, NASA needed a strong scientific organization at NASA Headquarters that worked with its own scientific advisory groups in order to mesh scientists and their experiments together with NASA's spacecraft, launch vehicles, and communication networks. Such strong headquarters organizations in Washington are usually not essential for the management of a large self-contained government-funded scientific facility and should be avoided.

It is particularly important to have a single principal investigator who is responsible for an experiment from conception to publication of results. This practice produces reliable, highly useful instruments because they are designed, built, and tested by each scientist with his or her experimental objectives firmly in mind. In a highly competitive climate with innovation a criterion for selection, it will also rapidly advance the instrument technology.

Scientists and engineers must work together on major research projects. Both are required, both will be more productive and less anxious when they understand each other's objectives and motivations. Good communication between all the people working on a research program is essential. Working scientists need to understand the objectives and management philosophy of the agency that supports their work; the leaders of the agency need to understand the objectives of the scientists and help solve the problems that they face.

EPILOGUE

After NASA Headquarters and the Space Science Board were reorganized in November 1961, NASA and its space scientists settled into a regular productive routine. After the early launch vehicle failures, NASA learned to build launch vehicles and spacecraft that normally worked. Instead of the only four out of ten successful missions in 1959, nine out ten missions were successful in the mid 1960s, thereby reducing one of the risks to space scientists. As more and more groups participated in successful missions and acquired large amounts of data, the competition became less severe and the failure to get aboard a mission less of a calamity. In turn, space scientists learned NASA procedures, served on the subcommittees, gained confidence in the integrity of the system, and recognized that submitting superior scientific proposals was the only way to get on NASA missions. NASA accepted most of the recommendations of the subcommittees, established new missions and issued Announcements of Flight Opportunity (AFOs). Scientists submitted proposals. NASA selected some and rejected others. Space science prospered through the first half of the 1960s.

In the mid-1960s—as students rioted in the streets, funding decreased for new space science missions, the number of space scientists continued to increase, competition became more intense, the NASA bureaucracy increased in size and power—the subcommittee procedures began to change. First to go was the personal appearance of the scientist before the subcommittee to plead his or her case and be questioned by the members of the subcommittee. The members of the subcommittees themselves brought about this change. They became concerned about this procedure. Didn't it give an unfair advantage to the articulate over the inarticulate scientist? Didn't it give the proposers an opportunity to subtly modify their proposal as they answered subcommittee questions? How could the members of a subcommittee be sure everyone was given an equitable opportunity to fly unless they based their judgments on written proposals that were all delivered to NASA on a specified date?

If the written proposal was to be the sole document upon which to base a decision, then great care had to be taken to ensure that the proposal contained all the relevant information needed for evaluation. As a result, AFOs and proposals became longer and more complex.

Next, the pressure from the NASA legal and procurement staffs to avoid any appearance of conflict of interest began to override the need to have the most competent scientists evaluate proposals. The chairperson had to exclude a member not only during the evaluation of his or her own proposal but also during the evaluation of any other proposals from that member's institution. Obviously, there was also a conflict of interest if a scientist reviewed a competitor's proposal. Subcommittee chairpersons found that before they could start to evaluate a set of proposals, they must examine all the proposals to be evaluated and then augment the membership of their subcommittees by additional consultants so that they had a group with no appearance of any conflict of interest with respect to any of the proposals.

As the flight opportunities decreased, however, and the number and quality of the competing scientists increased, it became virtually impossible to use active, knowledgeable space scientists to evaluate proposals—they all had conflicts of interest. In a little over a decade, the efforts to avoid any appearance of a conflict of interest had taken the selection out of the hands of the knowledgeable, experienced space scientist and placed it in the hands of "disinterested" scientists, with little or no knowledge of the field or the competence of the competing scientists. Fortunately, by the late 1980s, NASA recognized the need to relax some of its conflict-of-interest regulations and to begin once more to use competent practicing space scientists to evaluate proposals—but not their own, of course.

In the beginning, the Announcement of Flight Opportunity was essential and solved many of the problems in the selection process. Unfortunately, it also moved space science an enormous distance down the bureaucratic road. The AFO and the scientists' response to it became formidable documents. The fifth NASA AFO, issued in July 1965, ran 107 pages.[176] It described the NASA selection process and the opportunities for research on seven scientific missions, the Apollo Program, Explorers, sounding rockets, and the X-15 and Convair 990 research airplanes. Aspiring space scientists had to read all this, decide which missions interested them, then promptly inform NASA of those missions so that NASA could inform them of any changes in the schedule or the spacecraft for those missions. Proposals grew to 50 or 100 pages as the competing scientists strove to convince the subcommittees of the merits of their experiments. Finally, to cope with the burgeoning blizzard of paper, NASA placed a strict limit on the number of pages that could be included in a proposal.

NASA Abolishes the Subcommittees

As the number of scientific missions and the competition for their payload space increased during the mid-1960s, most of a subcommittee's time was taken up with evaluating experiments and little was available to help plan NASA's scientific missions. In 1966, NASA created the Lunar and Planetary Missions Board and the Astronomy Missions Board to plan most of NASA's scientific missions. In 1969, NASA revised its advisory structure, retaining the Space Science Steering Committee to oversee the selection process but eliminating the subcommittees. NASA changed 37–1–1 so that it required the program offices to establish, for each mission, a separate working group whose sole purpose was to evaluate the proposals for that particular mission. As a result, the corporate memory provided by the overlapping membership of the subcommittees was lost. NASA had to wait until it had received all the proposals for the mission before it appointed the members of the working group to be sure they had no conflict of interest.[177]

The aspiring, perspiring space scientist, however, no longer sits down by himself or herself to compose a fifty-page proposal. Instead, he or she assembles a large team of co-investigators to write individual parts of, and increase the credibility of, the proposal. Foreign scientists join the team to furnish part of the instrument and handle some of the data analysis. This reduces the cost of the instrument thereby making it more attractive to a program office trying to keep the overall cost of the mission down. Industrial subcontractors help prepare the proposal. Three to six months later the team, along with ten or so competing teams, delivers a tightly written proposal to NASA. According to McDonald, organizing a team of co-investigators and preparing a technical proposal limited to twenty-five pages is still the most difficult work a space scientist does.[178] NASA calls on a contractor to assemble the working group who will evaluate and place the proposals in the usual four categories. A Headquarters scientist uses the recommendations of the working group to select the teams to participate in the mission. Otherwise, the basic procedure is the much the same as that laid down in 37–1–1 in April 1960.

NASA's selection process continues to work. Generally, superior scientists are selected, their instruments perform well, and they make scientific discoveries. Scientists who are not selected occasionally protest the decision to the associate administrator for the Office of Space Science. Very rarely do they take their protest beyond the associate administrator to the NASA chief scientist or the NASA administrator. In 1971, Dr. Charles W. Townes, chairman of the Space Science Board, protested the selection of the scientists who had been chosen to conduct experiments during the Apollo-Soyuz mission, the joint American and Soviet mission. In this case, because of a shortage of time, the associate administrator for the Office of Space Science had decided not to follow TMI 37–1–1 and instead had selected a group of scientists who already had experiments ready. After Townes' protest, the associate administrator ran a high-speed selection process that rivaled that started by Lloyd Berkner's 4th-of-July telegram in 1958. Except for this instance, no scientist has overturned a decision made by an associate administrator for the Office of Space Science.

Although the selection process continues to work, the paperwork is enormous and the process is ponderous and impersonal. A decade or two may pass from the time NASA issues an AFO to the publication of the scientific results. Young, creative, ambitious scientists no longer find space science as attractive as they once did. To begin with, a space scientist can no longer expect to follow up an exciting discovery within a year or two. He or she must now wait ten to twenty years between major missions. Einstein, the last x-ray observatory, flew in 1978; AXAF, the Advanced X-Ray Astronomy Facility, the next U.S. x-ray observatory, will not fly until the mid-1990s. The last orbiting astronomical observatory ceased operation in the early 1970s; the next observatory, the Hubble telescope, was not launched until 1990. In addition, the length of time between missions, the cost and complexity of scientific instruments, and the size and caliber of the engineering team required to prepare an instrument make it extremely difficult for academic scientists to participate in the space science program.

Nevertheless, despite all the delays, the paperwork, and the risks of space flight, the exploration of the invisible universe beyond our atmosphere continues to challenge scientists and engineers. In February 1989, NASA announced the selection of scientists for the Earth Observing System (EOS);[179] 455 experiments were proposed for EOS. NASA selected 58 proposals involving 551 scientists from 168 institutions located in 32 states and 13 countries. The process for selecting space scientists continues to present a difficult and complex challenge to NASA Headquarters.

The Space Science Board recently completed a study that developed the strategy for an ambitious and exciting space program for the period 1995 through 2015.[180] The National Commission on Space proposed an agenda for the civilian space program for the next fifty years.[181] NASA reviewed four major space initiatives to see which to start in the next decade: Mission to Planet Earth, Exploration of the Solar System, Outpost on the Moon, and Humans to Mars.[182] On July 20, 1989, President George Bush announced a long-range commitment to space exploration, including a space station, a manned outpost on the Moon, and a manned mission to Mars.[183] It appears quite possible that in April 2060 an associate administrator for the Office of Space Science will be selecting space scientists using the same basic process prescribed in TMI 37–1–1 in April 1960.

NOTES

1. Homer E. Newell, *Beyond the Atmosphere, Early Years of Space Science*, NASA SP-4211 (Washington, D.C., 1980), pp. 33–44. Newell was a member of Krause's group at NRL. His book provides a complete history of the formation, membership, and work of the Panel throughout its existence.
2. James A. Van Allen, *Origins of Magnetospheric Physics* (Washington, D.C.: Smithsonian Institution Press, 1983), pp. 15–20. Van Allen was a charter member of the Panel and chairman from 1947 through 1958.
3. Van Allen, *Magnetosphere*, p. 17.
4. James A. Van Allen to John E. Naugle, March 15, 1989, comments on second draft, NASA History Office.
5. Van Allen, *Magnetosphere*, p. 18.
6. Newell, *Atmosphere*, p. 35.
7. Newell, *Atmosphere*, p. 41.
8. Allan A. Needell, *Lloyd Berkner, Merle Tuve, and the Federal Role in Radio Astronomy*, OSIRIS, 2nd series, 1987, 3: 261–288.
9. Newell, *Atmosphere*, p. 50.
10. Newell, *Atmosphere*, pp. 45, 425.
11. John W. Townsend, Jr., to John E. Naugle, February 13, 1989, comments on second draft, NASA History Office.
12. John A. Simpson to John E. Naugle, March 22, 1989, comments on second draft, NASA History Office.
13. Newell, *Atmosphere*, pp. 87–99.
14. John L. Sloop, *Liquid Hydrogen as a Propulsion Fuel, 1945–1959*, NASA SP-4404 (Washington, D.C., 1978), pp. 173–185.
15. Robert L. Rosholt, *An Administrative History of* NASA, 1958–1963, NASA SP-4101 (Washington, D.C.,1966), pp. 3–8.
16. *Minutes of the First Meeting, Technical Panel on Earth Satellite Program*, October 20, 1955, National Academy of Sciences (hereafter NAS) Archives, IGY Series, File: Minutes of TPESP.
17. *Minutes, First Meeting of Technical Panel*, Attachment 4.
18. John A. Simpson to John E. Naugle, March 22, 1989, comments on second draft, NASA History Office.
19. James A. Van Allen, ed., *Scientific Uses of Earth Satellites* (Ann Arbor: University of Michigan Press, 1956).
20. *Minutes of the Second Meeting, Technical Panel on Earth Satellite Program*, November 21, 1956, NAS Archives, IGY Series, File: Minutes of TPESP.

21. *Minutes of the Third Meeting, Technical Panel on Earth Satellite Program*, January 28, 1956, NAS Archives, IGY Series, File: Minutes of TPESP.

22. Van Allen, *Magnetosphere*, pp. 41–42.

23. *Minutes of the First Meeting of the Working Group on Internal Instrumentation*, March 2, 1956, NAS Archives, IGY Series, File: Minutes of WGII.

24. *Minutes of the Fourth Meeting, Technical Panel on Earth Satellite Program*, March 8–9, 1955, NAS Archives, IGY Series, File: Minutes of TPESP.

25. Van Allen, *Magnetosphere*, p. 42.

26. *Minutes of the Second Meeting of the Working Group on Internal Instrumentation*, June 1, 1956, NAS Archives, IGY Series, File: Minutes of WGII.

27. Van Allen, *Magnetosphere*, p. 42.

28. "Soviet Embassy Guests Hear of Satellite from an American as Russians Beam," *New York Times*, October 5, 1957.

29. Newell, *Atmosphere*, pp. 55–57.

30. Van Allen, *Magnetosphere*, pp. 43–47.

31. The *Washington Post* and *Times Herald*, November 8, 1957.

32. Rosholt, *Administrative History*, pp. 4–8. Rosholt provides an excellent summary of the activities leading to the creation of NASA.

33. Newell, *Atmosphere*, p. 93.

34. James A. Van Allen to John E. Naugle, March 15, 1989, comments on second draft, NASA History Office.

35. Van Allen, *Magnetosphere*, p. 55.

36. *Minutes of the Thirteenth Meeting, Technical Panel for the Earth Satellite Program*, October 22, 1957, NAS Archives, IGY Series, File: Minutes of TPESP.

37. R. Cargill Hall, *Lunar Impact, A History of Project Ranger*, NASA SP–4210 (Washington, D.C., 1977), pp. 6–10.

38. Dr. John A. Simpson to John E. Naugle, March 22, 1989, comments on second draft, NASA History Office.

39. *Tenth Meeting, Working Group on Internal Instrumentation*, May 26, 1958, NAS Archives, IGY Series, File: Minutes of WGII.

40. *Minutes of the Eighteenth Meeting of the Technical Panel of the Earth Satellite Program*, May 27, 1958, NAS Archives, IGY Series, File: Minutes of TPESP.

41. John A. Simpson to John E. Naugle, March 22, 1989, comments on second draft, NASA History Office.

42. For a more complete understanding of the forces shaping NASA in the winter of 1957 and 1958, see Robert L. Rosholt, *An Administrative History of*

NASA, 1958–1963, NASA SP–4101 (Washington, D.C., 1966); and Walter A. McDougall, *The Heavens and the Earth: A Political History of the Space Age* (New York: Basic Books, 1986).

43. Newell, *Atmosphere*, pp. 430–432.

44. Ken Hechler, *Toward the Endless Frontier, History of the Committee on Science and Technology*, 1959–1979 (Washington, D.C.: GPO, 1980), pp. 1–8.

45. Robert L. Rosholt, *Administrative History*, pp. 3–17.

46. Homer E. Newell, *Atmosphere*, pp. 87–99.

47. Rosholt, *Administrative History*, pp. 8–12.

48. Rosholt, *Administrative History*, pp. 19–34.

49. Rosholt, *Administrative History*, pp. 34, 35.

50. John L. Sloop, *Liquid Hydrogen as a Propulsion Fuel*, 1945–1959, NASA SP–4404 (Washington, D.C., 1978), pp. 180–185.

51. Rosholt, *Administrative History*, p. 35.

52. National Aeronautics and Space Act: Public Law 85–568, 85th Congress, H. R. 12575, July 29, 1958.

53. Rosholt, *Administrative History*, pp. 8–17.

54. Ibid.

55. Ibid.

56. Loyd S. Swenson, Jr., James M. Grimwood, Charles C. Alexander, *This New Ocean, A History of Project Mercury*, NASA SP–4201 (Washington, D.C., 1966), p. 101.

57. Space Act.

58. Hechler, *Frontier*, p. 11.

59. Sloop, *Hydrogen*, p. 185.

60. Hechler, *Frontier*, pp. 20, 21.

61. *Minutes of the Eighteenth Meeting of the Technical Panel of the Earth Satellite Program*, May 27, 1958, NAS Archives, IGY Series. File: Minutes of TPESP.,

62. Lloyd V. Berkner and Hugh Odishaw, eds., *Science in Space* (New York: McGraw-Hill, 1961), p. 429.

63. Robert O. Piland to Dr. James Killian, chairman, The President's Science Advisory Committee (PSAC), June 12, 1958, NASA History Office. Piland's memo is the only written record of this seminal meeting the author could find. Robert O. Piland, on detail to PSAC from the Langley Research Center, attended the meeting and reported the results to Killian.

64. Dr. Detlev W. Bronk to Lloyd V. Berkner, June 26, 1958, NAS Archives, Space Science Board Series. File: Administration.

65. *First Meeting of the Space Science Board*, June 27, 1958, NAS Archives, Space Science Board Series, File: Meetings.

66. Charles M. Atkins, NASA *and the Space Science Board of the National Academy of Sciences* (unpublished draft in the files of the NASA History Office). This document contains copies of NASA/SSB correspondence and much information on the relations between the Board and NASA in the early years of the space program. It contains a copy of the telegram sent by the Board.

67. Kinsey Anderson to John E. Naugle, March 29, 1989, comments on second draft, NASA History Office.

68. Odishaw to Dryden, July 24, 1958, NAS Archives, Space Science Board Series, File: Recommendations for Experiments.

69. Porter to Berkner, July 18, 1958, NAS Archives, Space Science Board Series, File: Recommendations for Experiments.

70. John A. Simpson to John E. Naugle, March 22, 1989, comments on second draft, NASA History Office.

71. *Minutes of the First Meeting of the Committee on Physics of Fields and Particles in Space*, October 14, 1958, NAS Archives, Space Science Board Series, File: Meetings.

72. Simpson to members of the Committee on Physics of Fields and Particles in Space, September 19, 1958, NAS Archives, Space Science Board Series, File: Meetings.

73. Goldberg to members of the Optical and Radio Astronomy Committee of the Space Science Board, September 26, 1958, NAS Archives, Space Science Board Series, File: Meetings.

74. *Minutes of the First Meeting of the Ad Hoc Committee on Optical and Radio Astronomy*, October 6, 1958, NAS Archives, Space Science Board Series, File: Meetings.

75. *Memorandum Report, December* 1, 1958, NAS Archives, Space Science Board Series, File: Recommendations for Space Experiments.

76. Hechler, *Frontier*, pp. 11–13.

77. Rosholt, *Administrative History*, pp. 40, 41.

78. Rosholt, *Administrative History*, p. 41.

79. Rosholt, *Administrative History*, pp. 48–50, 335.

80. Newell, *Atmosphere*, pp. 101–104.

81. Sloop, *Hydrogen*, pp. 180–185. Sloop presents an excellent description of Silverstein, his strengths and weaknesses, and mode of operation.

82. Rosholt, *Administrative History*, pp. 37–44.

83. Sloop, *Hydrogen*, pp. 180–185.

84. Newell, *Atmosphere*, p. 102.

85. John F. Clark to John E. Naugle, March 22, 1989, comments on second draft, NASA History Office.

86. Newell, *Atmosphere*, pp. 204, 205.

87. *Minutes of the Third Meeting of the Space Science Board*, October 24–25, 1958, NAS Archives, Space Science Board Series, File: Meetings.

88. *Scientific Research in Space*, 1958, *Draft* II, NAS Archives, Space Science Board Series. There is no record as to who wrote this draft or when it was written. Odishaw probably drafted it for consideration by the Board at the third meeting. The Board never published this version of the document. A much modified version, which describes quite different roles for NASA and the Board, was published in *Science* ("Research in Space," Vol. 130, No. 3369, July 24, 1959).

89. Homer E. Newell Jr., *Conference Report, Space Science Board Meeting*, October 24–25, 1958, NASA History Office.

90. Ibid.

91. Ibid.

92. *Minutes of Third Meeting of Space Science Board*.

93. Newell, *Conference Report*, October 24–25.

94. Homer E. Newell, Jr., *Memorandum for Record*, October 29, 1958, NASA History Office, Homer E. Newell Files, Box 6, File 162.

95. Silverstein to Glennan, *Proposed* NASA *Policy on Space Flight Experiments*, December 12, 1958, NASA History Office.

96. Minutes of the Administrator's Staff Meeting, December 15, 1958, NASA History Office.

97. NASA *Policy on Space Flight Experiments*, December 12, 1958.

98. Glennan to Odishaw, December 23, 1958, NASA History Office.

99. Clayton R. Koppes, JPL *and the American Space Program: A History of the Jet Propulsion Laboratory* (New Haven, Conn.: Yale University Press, 1982), pp. 94–112.

100. Rosholt, *Administrative History*, p. 48, Fig. 3–3.

101. John A. Simpson to John E. Naugle, comments on second draft, April 3, 1989, NASA History Office.

102. Townsend to Newell, February 6, 1959, NASA Archives, Newell Files, Box 6, File 162.

103. Townsend, February 6, 1959.

104. Newell, *Atmosphere*, p. 204.

105. Richard Witkin, "Missile Blown up at Launching," *New York Times*, September 17, 1959.

106. Hanson W. Baldwin, "Russia's Moon Shot Again Demonstrates Its Lead in Space Race," *New York Times*, September 20, 1959.

107. John W. Finney, "U.S. Space Program Far Behind Soviet's," *New York Times*, October 10, 1959.

108. William Hines, "U.S. Out of Space Race For at Least 2 Years," *Washington Star*, November 29, 1959.

109. Hall, *Project Ranger*, p. 13. Hall's book provides a history and bibliography of NASA's lunar program.

110. James MacNees, "House Group Planning Wide Hearings Next Session, Brooks Says," *Baltimore Sun*, October 29, 1959.

111. John Van Camp, "Leadership of World is Involved, He Says," *Baltimore Sun*, December 18, 1959.

112. Hall, *Project Ranger*, pp. 46–80.

113. N. F. Ness, C. S. Scearce, and J. B. Seek, "Initial Results of the IMP–1 Magnetic Field Experiment," *Journal of Geophysical Research*, Vol. 69 (1964), pp. 3531–3569

114. Hugh Odishaw, *Memorandum Report*, December 1, 1958, NAS Archives, Space Science Board Series. File: SSB Reports.

115. Frank B. McDonald to John E. Naugle, 10 March 1989, comments on second draft. NASA History Office.

116. William R. Corliss, *Scientific Satellites*, NASA SP–133, (Washington, D.C., 1967), pp. 725,726.

117. *Minutes of the First Meeting, Committee on Physics of Fields and Particles in Space*, October 14,15, 1958, NAS Archives, Space Science Board Series. File: Meetings.

118. Odishaw, *Memorandum Report*, December 1, 1958.

119. Corliss, *Satellites*, pp. 765–767.

120. Corliss, *Satellites*, pp. 723.

121. Odishaw, *Memorandum Report*, December 1, 1958.

122. John F. Clark to John E. Naugle, 22 March 1989, comments on second draft. NASA History Office.

123. Newell to Shilling; Newell to Clark, October 10, 1959, NASA History Office, Newell Files: Box 6, File 173.

124. Newell's Dairies, October 20, 1959, NASA History Office.

125. Hall, *Project Ranger*, p. 18.

126. Space Science Board, "Research in Space," *Science*, Vol. 130, July 24, 1959, pp. 3–10.

127. *Ten-Year Space Science Program*, Odishaw to members, Space Science Board and Committees, July 30, 1959, NAS Archives, Space Science Board Series, File: Science Programs.

128. Dryden to Cornell, October 20, 1958, NASA History Office.

129. Berkner to Kistiakowsky, November 13, 1959, Transmittal Letter, Report to the President's Scientific Advisory Committee, November, 1959, NAS Archives, Space Science Board Series, File: Report to PSAC.

130. Odishaw to SSB Committee Chairmen and Members, February 5, 1960, NAS Archives, Space Science Board Series, File: Memoranda, SSB–139.

131. *Report to the President's Scientific Advisory Committee, November*, 1959, NAS Archives, Space Science Board Series, File: Report to PSAC.

132. Rosholt, *Administrative History*, pp. 107–116.

133. Horner to Pickering, December 16, 1959, NASA History Office, Newell Files: Box 6, File 163.

134. Pickering to Silverstein, December 17, 1959, NASA History Office, Newell Files, Box 6, File 163.

135. Silverstein to Pickering, December 21, 1959, NASA History Office, Newell Files, Box 6, File 163.

136. Dr. Homer E. Newell, *Memorandum for the file*, December 30, 1959, NASA History Office, Newell Files, Box 6, File 163.

137. John A. Simpson to John E. Naugle, April 3, 1989, comments on second draft. NASA History Office.

138. Silverstein to Pickering, January 26, 1960, NASA History Office, Newell Files, Box 6, File 163. This letter is also interesting because it illustrates the way NASA Headquarters operated in 1960. Cortright, as the newly designated assistant director for Lunar and Planetary Programs, prepared the letter and Newell, the newly designated deputy to Silverstein, signed it for Silverstein.

139. Rosholt, *Administrative History*, pp. 340, 341.

140. Newell to Stoller, *Approval of* LRL *Experiment*, February 9, 1960. In this memo Newell directs Stoller to prepare a memorandum to Silverstein requesting his approval of the experiment. There is no mention of the Steering Committee in this memo.

141. Newell to Cortright, *Meeting of Steering Committee*, February 11, 1960, NASA History Office. Newell calls a meeting of the Steering Committee to consider a "John Winckler Proposal". This is the first mention of the Steering Committee in NASA correspondence.

142. John F. Clark to John E. Naugle, March 23, 1989, comments on second draft. NASA History Office.

143. *Establishment and Conduct of Space Sciences Program—Selection of Scientific Experiments*, TMI 37-1-1, April 15, 1960. NASA History Office.

144. Minutes of the Space Science Steering Committee, Meeting No. 1, February 16, 1960. NASA History Office.

145. Minutes of the Space Science Steering Committee, Meeting No. 2, March 4, 1960. NASA History Office.

146. Minutes of the Space Science Steering Committee, Meeting No. 4, March 16, 1960. NASA History Office.

147. Ibid.

148. Pickering to Newell, March 22, 1960. NASA History Office, Newell Files, Box 6, File 163.

149. Minutes of the Space Science Steering Committee, Meeting No. 5, March 21, 1960. NASA History Office.

150. Minutes of the Space Science Steering Committee, Meeting No. 8, April 4, 1960. NASA History Office.

151. Minutes of the Space Science Steering Committee, Meeting No. 44, November 28, 1960. NASA History Office.

152. Minutes of the Space Science Steering Committee, Meeting No. 45, December 5, 1960. NASA History Office.

153. Minutes of the Space Science Steering Committee, Meeting No. 9, April 11, 1960. NASA History Office.

154. Newell, Memorandum for the Files, April 13, 1960, NASA History Office, Newell Files, Box 6, File 175.

155. Naugle to Newell (via Clark and Stoller), *Formation of the Fields and Particles Subcommittee*, April 1, 1960. Minutes of the Particles and Fields Subcommittee. NASA History Office.

156. Minutes of the Particles and Fields Subcommittee, Meeting No. 1, May 3, 1960. NASA History Office.

157. Minutes of the Particles and Fields Subcommittee, Meeting No. 2, May 19, 1960. NASA History Office.

158. Hall, *Project Ranger*, pp. 74–77.

159. Minutes of the Particles and Fields Subcommittee, Meeting No. 3, July 11–12, 1960. NASA History Office.

160. Naugle to Newell, July 22, 1960, and Minutes of the Particles and Fields Subcommittee, Meeting No. 3, July 11, 1960. NASA History Office.

161. Minutes of the Particles and Fields Subcommittee, Meeting No. 6, May 25, 1961. NASA History Office

162. Minutes of the Particles and Fields Subcommittee, Meeting No. 7, October 4, 1961. NASA History Office.

163. Minutes of the Particles and Fields Subcommittee, Meeting No. 10, June 7, 1962. NASA History Office.

164. Minutes of the Particles and Fields Subcommittee, Meeting No. 1–63, September 6, 7, 1962. NASA History Office.

165. Minutes of the Particles and Fields Subcommittee, April 30, 1983. Minutes of the Space Science Steering Committee, June 17, 1963, July 22, 1963. NASA History Office.

166. Newell to Dryden, February 18, 1960. NASA History Office, Newell Files, Box 6, File 179.

167. Berkner to Kistiakowsky, November 13, 1959.

168. Pearman to Odishaw, et al., February 3, 1961. NAS Archives, Space Science Board Series. File: Physics of Fields and Particles in Space.

169. Rosholt, *Administrative History*, p. 344.

170. NASA Management Manual Instruction 37–1–1A. NASA History Office.

171. Newell, *Atmosphere*, pp. 223–237.

172. Dryden to Berkner, October 25, 1961. NAS Archives, Space Science Board Series. File: NASA Reorganization.

173. Berkner to Members of the Space Science Board, November 3, 1961. NAS Archives, Space Science Board Series. File: Reorganization.

174. Berkner to Bronk, January 5, 1962. NAS Archives, Space Science Board Series. File: Reorganization.

175. James A. Van Allen to John E. Naugle, March 15, 1989, comments on second draft. NASA History Office.

176. *Opportunities for Participation in Space Flight Investigations*, NHB 8030.1, Issued by the Office of Space Science and Applications, July 1965. NASA History Office.

177. Newell, *Atmosphere*, pp. 216–219.

178. F. B. McDonald to John E. Naugle, comments on second draft, March 10, 1989. NASA History Office.

179. "*NASA Announces Earth Observation System Investigations*," NASA News Release 89–15, February 8, 1989. NASA History Office.

180. Space Science Board, *Space Science in the Twenty-First Century, Imperatives for the Decades 1995 to 2015*, (Washington, D. C.: National Academy Press, 1988).

181. National Commission on Space, *Pioneering the Space Frontier*, (New York: Bantam Books, 1986).

182. Sally K. Ride, *Leadership and America's Future in Space, A Report to the NASA Administrator*, 1987. NASA History Office.

183. White House Press Release, July 20, 1989.

ABOUT THE AUTHOR

John Earl Naugle devoted many years to aerospace research and administration. He began his career by studying cosmic rays, using nuclear emulsions exposed during high altitude balloon flights. Later, the same emulsions were carrried on sounding rockets. In 1959, Mr. Naugle joined the Goddard Space Flight Center, where he continued to use sounding rockets to study the protons in the magnetosphere. In 1960, he took charge of the Fields and Particles Program at NASA Headquarters, where he remained until his retirement in 1981. During his years at NASA Headquarters, Mr Naugle served as a principal investigator, director of the Physics and Astronomy Program, associate administrator for the Office of Space Science, associate administrator of the agency, and finally as chief scientist. Mr. Naugle is now enjoying his retirement on Cape Cod, where he continues to write about the early history of space science.

THE NASA HISTORY SERIES

HISTORIES

Anderson, Frank W., Jr., *Orders of Magnitude: A History of NACA and NASA, 1915–1980* (NASA SP–4403, 2d ed., 1981).

Benson, Charles D., and William Barnaby Faherty, *Moonport: A History of Apollo Launch Facilities and Operations* (NASA SP-4204, 1978).

Bilstein, Roger E., *Orders of Magnitude: A History of the NACA and NASA, 1915–1990* (NASA SP-4406, 1989).

Bilstein, Roger E., *Stages to Saturn: A Technological History of Apollo/Saturn Launch Vehicles* (NASA SP–4206, 1980).

Boone, W. Fred, *NASA Office of Defense Affairs: The First Five Years* (NASA HHR-32, 1970, multilith).

Brooks, Courtney G., James M. Grimwood, and Lloyd S. Swenson, Jr., *Chariots for Apollo: A History of Manned Lunar Spacecraft* (NASA SP-4205, 1979).

Byers, Bruce K., *Destination Moon: A History of the Lunar Orbiter Program* (NASA TM X-3487, 1977, multilith).

Compton, W. David, *Where No Man Has Gone Before* (NASA SP-4214, 1989).

Compton, W. David, and Charles D. Benson, *Living and Working in Space: A History of Skylab* (NASA SP-4208, 1983).

Corliss, William R., *NASA Sounding Rockets, 1958–1968: A Historical Summary* (NASA SP-4401, 1971).

Dawson, Virginia P., *Engines and Innovation: Lewis Laboratory and American Propulsion Technology* (NASA SP–4306, 1991).

Ezell, Edward Clinton, and Linda Neumann Ezell, *On Mars: Exploration of the Red Planet, 1958–1978* (NASA SP-4212, 1984).

Ezell, Edward Clinton, and Linda Neumann Ezell, *The Partnerships: A History of the Apollo-Soyuz Test Project* (NASA SP-4029, 1978).

Green, Constance McL., and Milton Lomask, *Vanguard: A History* (NASA SP-4202, 1970; also Washington: Smithsonian Institution Press, 1971).

Hacker, Barton C., and James W. Grimwood, *On the Shoulders of Titans: A History of Project Gemini* (NASA SP-4203, 1977).

Hansen, James R., *Engineer In Charge: A History of the Langley Aeronautical Laboratory, 1917–1958* (NASA SP-4305, 1987).

Hall, R. Cargil, *Lunar Impact: A History of Project Ranger* (NASA SP-4210, 1977).

Hallion, Richard P., *On the Frontier: Flight Research at Dryden, 1946–1981* (NASA SP-4303, 1984).

Hartman, Edwin P., *Adventures in Research: A History of Ames Research Center, 1940–1965* (NASA SP-4302, 1970).

Levine, Arnold, *Managing NASA in the Apollo Era* (NASA SP-4102, 1982).

Muenger, Elizabeth A., *Searching the Horizon: A History of Ames Research Center, 1940–1976* (NASA SP-4304, 1985).

Newell, Homer E., *Beyond the Atmosphere: Early Years of Space Science* (NASA SP-4211, 1980).

Pitt, John A., *The Human Factor: Biomedicine in the Manned Space Program, 1980* (NASA SP-4213, 1985).

Roland, Alex, *Model Research: The National Advisory Committee for Aeronautics, 1915–1958* (NASA SP-4103, 1985).

Roland, Alex, *A Spacefaring People: Perspective on Early Spaceflight* (NASA SP-4405, 1985).

Rosenthal, Alfred, *Venture into Space: Early Years of Goddard Space Flight Center* (NASA SP-4103, 1985).

Rosholt, Robert L., *An Administrative History of NASA, 1958–1963* (NASA SP-4101, 1966).

Sloop, John L., *Liquid Hydrogen as a Propulsion Fuel, 1945–1959* (NASA SP-4404, 1978).

Swenson, Lloyd S., Jr., James M. Grimwood and Charles C. Alexander, *This New Ocean: A History of Project Mercury* (NASA SP-4201, 1966).

REFERENCE WORK

Aeronautics and Space Report of the President, annual volumes for 1975–1988.

The Apollo Spacecraft: A Chronology of Science, Technology, and Policy, annual volumes with an earlier summary volume, *Aeronautics and Astronautics, 1915–1960*.

Dickson, Katherine M., ed., *History of Aeronautics and Astronautics: A Preliminary Bibliography* (NASA HHR-29, 1968, multilith).

Ezell, Linda Neumann, *NASA Historical Data Book*, vol. II *Programs and Projects 1958–1968* and vol. III *Programs and Projects 1969–1978* (NASA SP-4102, 1988).

Hall, R. Cargill, *Project Ranger: A Chronology* (JPL/HR-2, 1971, multilith).

Hall, R. Cargill, ed., *Essays on the History of Rocketry and Astronautics: Proceedings of the Third through the Sixth History Symposia of the International Academy of Astronautics* (NASA CP-2014, 2 vols., 1977).

Looney, John J., ed., *Bibliography of Space Books and Articles from Non-Aerospace Journals*, 1957–1977 (NASA HHR-51, 1979, multilith).

Roland, Alex F., *A Guide to Research in NASA History* (NASA HHR-50, 6th ed., 1982, available from NASA History Office).

Skylab: A Chronology (NASA SP–4011, 1977).

Van Nimmen, Jane, and Leonard C. Bruno, with Robert L. Rosholt, *NASA Historical Data Book*, 1958–1968, vol. 1, *NASA Resources* (NASA SP–4102, 1976).

Wells, Helen T., Susan H. Whiteley, and Carrie E. Karegeannes, *Origins of NASA Names* (NASA SP–4402, 1976).