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United States
General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

B-251848



148414

January 12, 1993

The Honorable Daniel S. Goldin
Administrator, National Aeronautics
and Space Administration

Dear Mr. Goldin:

We have completed our survey of NASA's selection, utilization, and training of astronauts. Our work focused on the size and composition of the astronaut corps, the average length of service in the corps, the frequency of flight for astronauts, trends in astronauts' waiting times to first and subsequent flights, and NASA's response to astronauts' concerns about training.

RESULTS IN BRIEF

Since the late 1970s the astronaut corps has grown substantially in size and the mix of astronaut pilot and mission specialist candidates has changed, primarily to provide larger crews to staff longer, more complex missions. Once candidates become astronauts, they typically remain in the corps well beyond the 5-year expected minimum length of service.

Knowing how often an astronaut should be allowed to fly is an important element in determining the size of the astronaut corps. NASA officials at the Johnson Space Center believe that, generally, astronauts should not fly more than once a year because of the rigors of, and the time required for, mission training. However, there are no generally accepted criteria on how frequently an astronaut should be permitted to fly missions.

Utilization statistics show favorable recent trends towards more efficient use of astronauts after a period of generally increasing waiting times to first and subsequent flights early in the space shuttle program. Also, the flight opportunities for astronauts are fairly well distributed.

GAO/NSIAD-93-114R Astronaut Utilization

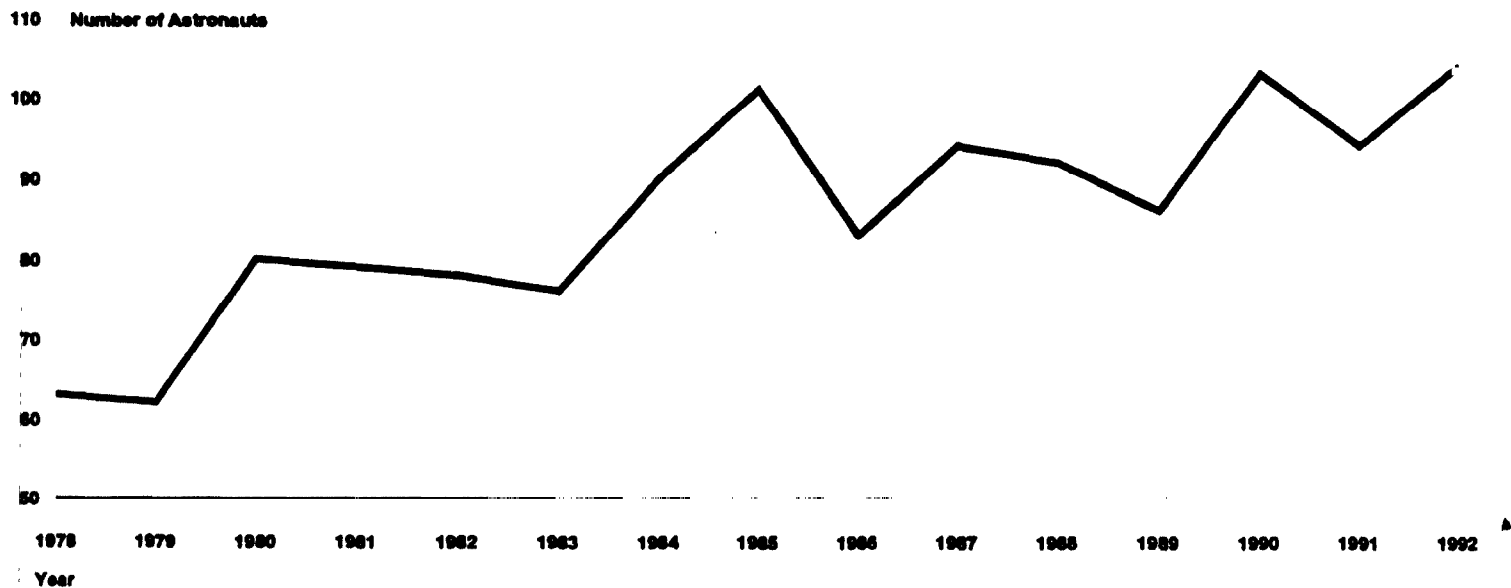
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Both the NASA Inspector General staff and NASA Headquarters personnel have determined that NASA officials at Johnson took actions responsive to the recommendations in a 1990 Inspector General's report that summarized astronauts' concerns about the adequacy of their flight crew training.

GROWTH IN THE SIZE OF THE ASTRONAUT CORPS

There are no written policies or procedures to determine the size of the corps. However, NASA officials at Johnson told us that in estimating the number and skill mix of astronaut candidates needed, they consider the corps' attrition rate, the number and nature of upcoming missions, and the number of technical assignments that need to be staffed by astronauts. The size of the astronaut corps increased from 62 in the late 1970s to 104 in 1992, as shown in figure 1.

Figure 1: Number of Astronauts, 1978-92



NASA officials at Johnson explained that the size of the astronaut corps grew substantially without relatively comparable growth in the number of shuttle flights because of the shuttle program's evolution towards larger crews flying longer and more complex missions, as well as increased astronaut involvement in technical assignments.

Originally, shuttle flights were generally short missions for deploying satellites that lasted less than a week and were staffed by crews of two to four astronauts. Since then, shuttle missions have generally evolved to include a variety of space-based activities requiring longer missions and larger crews. In addition, following the Challenger accident, astronauts became much more involved with various facets of the shuttle program, as recommended by the Rogers Commission that examined the causes of the accident. Astronauts are also now increasingly involved in other technical assignments associated with the development of Space Station Freedom and other programs throughout the agency.

ASTRONAUTS' LENGTH OF SERVICE EXCEEDS MINIMUM EXPECTATION

There are no formal contracts between NASA and members of the astronaut corps that specify a minimum service obligation. There is, however, an expectation of 5 years of service stated in NASA's announcement for astronaut candidates.

To date, all astronauts have exceeded this expectation. Although a few astronauts have resigned from the corps within a year after completing 5-years' service, most have served much longer. The average length of service for current astronauts who joined the corps since 1978 is 10.2 years--more than twice the minimum expectation. The average length of service for all astronauts who have ever flown on the space shuttle is 13.8 years--almost three times the minimum expectation.

COMPOSITION OF ASTRONAUT CORPS HAS CHANGED

In 1978, there were 32 mission specialists and 31 pilots in the astronaut corps. Since then, lower than planned flight rates have decreased the need for pilots; while, at the same time, the changing nature of missions from simple satellite deployments to a variety of space-based activities has increased the need for mission specialists.

Consequently, NASA recently changed the selection ratio of mission specialists to pilots. As depicted in Figure 2, roughly 6 mission specialists for every 4 pilots were hired for the 1978 class. That ratio, without substantial variation, continued for each class throughout the 1980s. There were increasingly heavy proportions of mission specialists hired for the 1990 and 1992 classes. As a result, the overall composition of the astronaut corps has been

changed from about equal numbers to about 6 mission specialists for every 4 pilots.

Figure 2: Mission Specialist and Pilots Hired, 1978-92



FLIGHT OPPORTUNITY DISTRIBUTION AND ASTRONAUT UTILIZATION

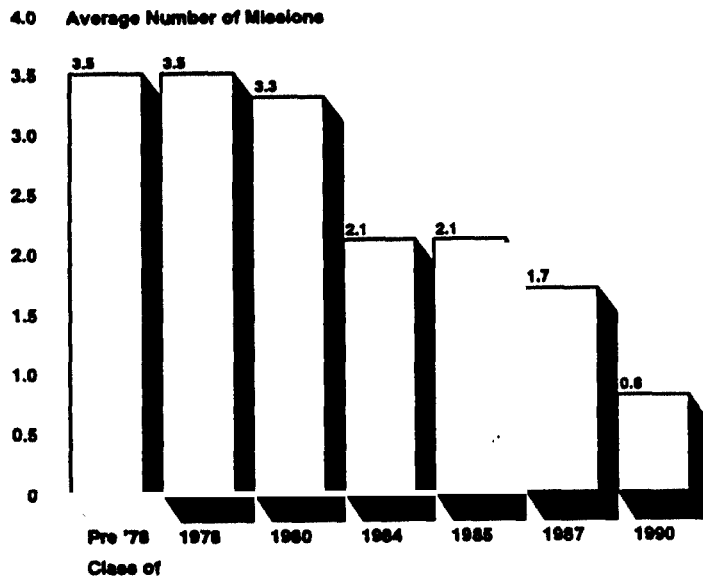
Because there are no authoritative criteria on how often astronauts should fly, we assessed astronaut utilization on missions from a variety of perspectives, principally to determine trends. Overall, flight opportunities have been relatively well distributed among the astronauts and astronaut utilization has been increasing dramatically in recent years.

To examine flight opportunity and utilization trend data, we determined the number of flights for each member of the current corps and the average number of flights for their candidate classes. We also calculated the average wait time to first and subsequent missions for each astronaut class since 1978 and the average mission wait time for all astronauts flying each year between 1981 and 1992.

The number of shuttle missions flown by each member of a particular astronaut class is generally about the same. For

example, almost all astronaut candidates hired in 1980 or earlier have now flown at least three or four times, while those hired in the mid-1980s have typically flown twice. There were some exceptions. In all, six astronauts have flown fewer missions than their peers or have waited longer to fly. Most of these astronauts had been the victims of delays in their missions' schedules. Overall, the number of missions tends to increase with length of service in the corps, as depicted in figure 3.

Figure 3: Average Number of Missions Flown or Scheduled Through 1993 by Astronaut Class (current corps only)



The average time astronauts wait for their missions has been decreasing since the return to flight in 1988 following the Challenger accident. Average waiting time to first missions has decreased sharply from approximately 5 years for the astronaut classes of the late 1970s through mid-1980s, to about 2 years for the class of 1990, as shown in figure 4. Since astronauts typically spend about a year in basic training before they are ready to be assigned to a mission, we calculated the time to first mission from the date an astronaut was first eligible to be assigned a mission. Similarly, the average time between missions shows a decreasing trend, as shown in figure 5.

Figure 4: Average Time to First Mission by Astronaut Class

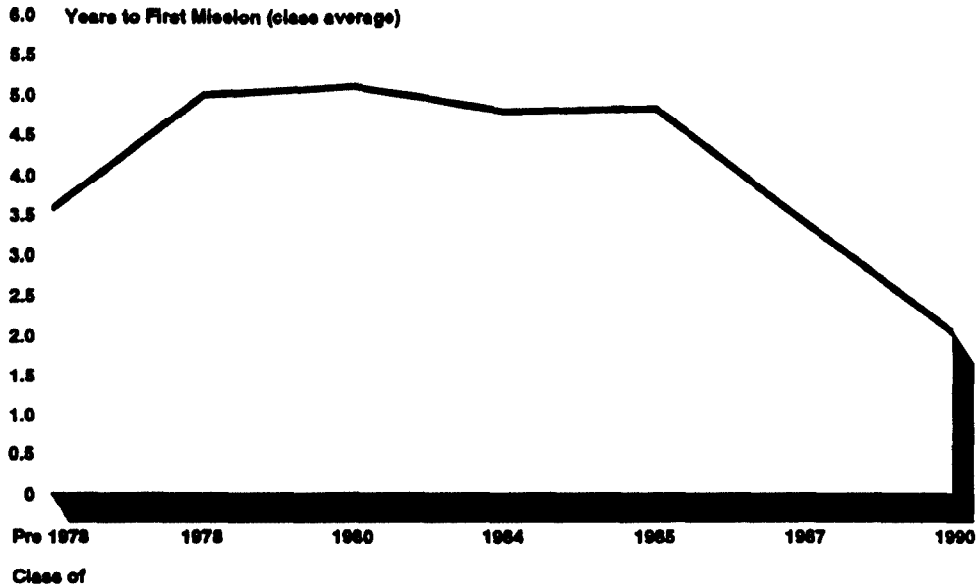
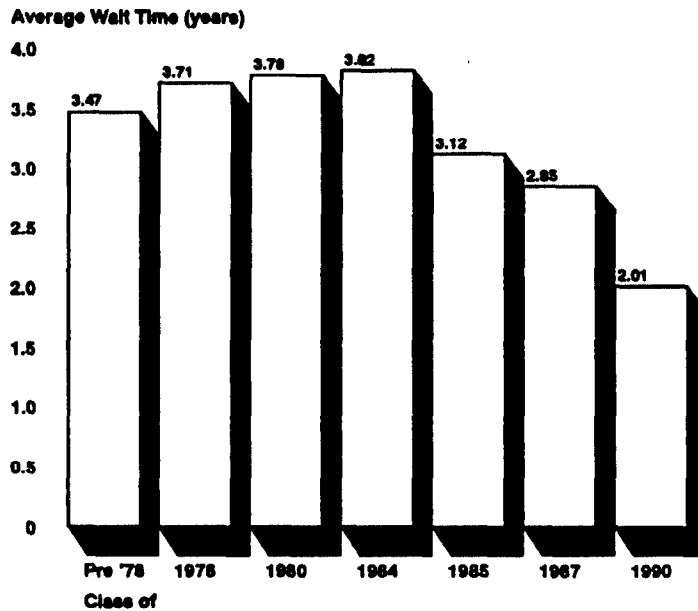


Figure 5: Average Time Between Mission by Astronaut Class



The average waiting time for all astronauts who flew in a particular year has also been declining dramatically after hitting its highest point in 1989 at almost 5 years. While astronauts waited an average of 4 years for missions launched in 1990, the current average wait is well under 3 years, as shown in figure 6.

Figure 6: Average Wait Time by Flight Year



Note: Due to the Challenger accident, no missions were flown in 1987.

Astronauts serve on technical assignments when they are not training for or performing missions. Typically, after completing a mission, astronauts are given a technical assignment before being assigned their next mission. Technical assignments serve several purposes: they give astronauts a broader experience base and expose them to various parts of the space shuttle and space station programs, they provide the astronauts with a break from the rigor and time demands of mission training, and they provide end-user input to project developers and designers.

NASA RESPONSIVE TO INSPECTOR GENERAL
REPORT ON ASTRONAUT TRAINING

In August 1990, the NASA Inspector General staff at Johnson issued a report on flight crew training. Based on responses to an astronaut questionnaire, the report recommended that, among other things, the Johnson Center Director evaluate the adequacy of astronaut training facilities and equipment, and determine if Johnson training facilities and personnel were adequate to support the projected shuttle flight rate.

In July 1991, Johnson management stated that because of actions taken, it considered the report's recommendations and the audit closed. The Office of Inspector General at Johnson concurred, and closed the audit. In June 1992, NASA Headquarters validated that Johnson had completed the actions in response to the report.

Our reviews of the audit file and discussions with NASA training personnel at the center revealed that Johnson had responded to the report's recommendations. Among other things, the number of training instructors had increased and the Shuttle Mission Training Facility is being upgraded. The upgrade is scheduled to be completed by the end of fiscal year 1993. With regard to the adequacy of training facilities and personnel to support the shuttle flight rate, Johnson found that it could support 12 flights a year with additional personnel. As the current projected flight rate does not exceed eight per year, the training facilities and personnel were deemed adequate to meet the flight rate.

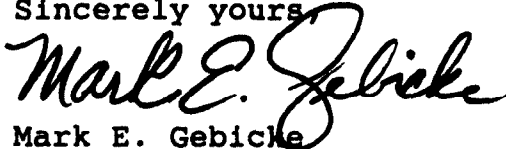
SCOPE AND METHODOLOGY

Our work was performed at NASA's Johnson Space Center from August to December 1992. In order to analyze astronaut utilization, we developed a data base including information on each astronaut entering the corps since 1978. We also developed similar information on astronauts who were in the corps prior to 1978 and flew on the space shuttle. We began with the astronaut candidate class of 1978 because it was the first class that was recruited specifically for the shuttle program. Our work in the training area was limited to following up on the responsiveness of NASA officials at Johnson to the Inspector General's report on flight crew training.

B-251848

The Flight Crew Operations Directorate at Johnson expressed an interest in our data base, and has been provided a copy. We appreciate the courtesies and cooperation extended to our staff by NASA personnel during our survey. If you have any questions, please contact me on (202) 275-5140.

Sincerely yours,



Mark E. Gebicke
Director, NASA Issues

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GAO/NSIAD-93-114R Astronaut Utilization