


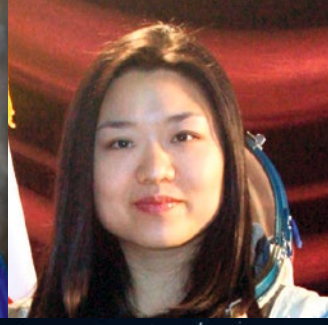

WOMEN SPACEFARERS

Sixty Different Paths to Space




Umberto Cavallaro



Springer

PRAXIS

Women Spacefarers

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To Lorenzo and Martina
Aim high and chase your dreams!

Acronyms

ASI	Agenzia Spaziale Italiana (Italian Space Agency)
ASP	Astronaut Support Personnel (see *Cape Crusader*)
CAIB	Columbia Accident Investigation Board
CCCP	Советская космическая программа (Soviet space program)
CNES	Centre National d'Études Spatiales (French Space Agency)
CNSA	China National Space Administration
CSA	Canadian Space Agency
DLR	Deutsches Zentrum für Luft- und Raumfahrt (German Aerospace Center)
EMU	Extravehicular Mobility Unit, i.e., a spacesuit
ESA	European Space Agency
EVA	Extravehicular Activity
ISS	International Space Station
JAXA	Japan Aerospace Exploration Agency
JSC	NASA Johnson Space Center, Houston, Texas
KARI	Korean Aerospace Research Institute
KSC	NASA Kennedy Space Center, Florida
MCC	Mission Control Center
NASA	National Aeronautics and Space Administration
ROSCOSMOS	Федеральное космическое агентство (Russian Federal Space Agency)
SAS	Space Adaptation Syndrome or Space Sickness
STS	Shuttle Transport System or Space Shuttle
TRDS	Tracking and Data Relay Satellite
UNOOSA	United Nations Office for Outer Space Affairs
USAF	United States Air Force

Contents

Foreword

Writing an introduction to a book is always challenging, mainly if the goal is to say something new and special every time. Writing the introduction to a book on space is even more challenging because, as space is my day-to-day life, extremely high attention must be paid on what I write and how I do it. But writing the introduction to *Women Spacefarers—Sixty Different Paths to Space* by Umberto Cavallaro has been difficult and inspiring at the same time. Why? Let's start with some statistics. At the time at which this book is being printed, we can count 60 human beings of the female gender who have left Earth to fly into space—60 women out of about 550 astronauts, cosmonauts, and taikonauts in 55 years (from Yuri Gagarin in 1961 until today). Still, 60 out of 550 means about 11 %. Well, let's make a comparison between the total number of flights instead. We can count about 1100 flights made by men and about 130 made by women, for a total of about 43,700 days in orbit, against 3700. The only "first" for a woman comes with Susan Helms, who, together with James Voss, still holds the record for the longest extravehicular activity (i.e., 8 h and 56 min, during STS-102 on March 11, 2001). And, just to underline another unique event, let's go back to 2007 when Peggy Witson, ISS commander, welcomed Pamela Melroy, Shuttle commander, aboard the International Space Station (ISS). What sounds strange here is that these events are so rare. And they merit mention exactly because they are so rare.

These figures represent well the overall situation in the scientific domain, and in particular in the aerospace field, where we can count an average of about 15 % of experts of the female gender in the workforce.

Let's look at this situation from a different viewpoint. Indeed, the ultimate goal of sending humans into space is to perform scientific experiments in microgravity conditions, and it is nowadays crystal clear that men and women have different reactions to weightlessness. NASA and the National Space Biomedical Research Institute (NSBRI) conducted a study, published in 2014, on the basis of a request stemming out of a 2011 National Academy of Science decadal survey report. The main result of this study is that there are key differences between men and women in cardiovascular, immunologic, sensorimotor, musculoskeletal, and behavioral adaptations to human spaceflight. Among various recommendations, the study suggested selecting more female astronauts for future spaceflights and designing

scientific experiments considering the gender aspect. As a natural consequence, the last NASA astronaut class, selected in 2015, was made up of eight human beings: 50 % male and 50 % female. All in all, this balanced selection is nothing other than a scientific result.

Apart from these female heroes, every mission into space has been possible because of hundreds of men and women, working as a team, all over the world. All of them are passionate about their jobs and about space, even if they never flew in space, and probably never will. During my career, I moved to be an astrophysicist to become a manager, working always in the development of programs with international cooperation. I never flew in space, but I allowed astronauts to fly, missions to be launched successfully, and experiments to be performed in space to improve our quality of life on Earth. In this respect, one of the questions I get asked the most is: What brought you into the space field and in your current position as Director of the Office for Outer Space Affairs at the United Nations? I always say that actively participating in the aerospace field gave me a feeling of fulfillment and pride in human achievements. It changed my perspective on humanity, detaching myself from the daily routine and thinking about the world as a whole, understanding our hyperconnectivity and interdependence. In addition, I have been an advocate for the use of space research and technology as a tool for sustainable development on Earth for a long time. A stronger and narrower cooperation in the space sector among all involved stakeholders is necessary to achieve the most cutting-edge results. At the same time, I firmly believe that the rise of new actors is transforming the current playground and the need for shared international rules is crucial. What have I been looking for in my career then? Well, those factors, coupled with the fact that my position at the UN perfectly satisfies my need for continuous intellectual impetus, my willingness to learn something new every day, to meet new people, lead me to this challenge. It is really important to have those feelings when choosing your career. My inspiration every day comes from the clear and tangible outputs of the use of space research, technology, and applications for the improvement of the quality of life on Earth. An example? Space-based technology and applications are used to gather information that can help us to understand global water cycles, map water courses, and monitor and mitigate the effects of floods and droughts.

And, as women suffer disproportionably from poverty, they are more likely to be affected by natural disasters as well as climate change and its impacts. We should think of women in these environments not only as victims, but rather as powerful agents of change, who possess specific knowledge and skills to effectively contribute to climate change adaptation and mitigation, and to the prevention of and education on natural disasters.

At the UN, we do capacity building and we are now in the process of changing the approach to it after 50 years since the start of the space era. We are working therefore to define new innovative and effective approaches to overall capacity building and development needs as a fundamental pillar of global space governance, strengthening comprehensive outreach activities. We are also working to promote efforts to encourage science, technology, engineering, and mathematics education, especially for women in developing countries. And, in doing so, we really need role models. The 60 women in this *Women Spacefarers* book are heroes—role models to be followed. But also, all the space experts of the female gender who are not leaving Earth, but for 50 years have allowed space missions to become a reality together with their male colleagues, of different nationalities, in different places in the world, all working for the same goal, merit recognition as role models—evidence that yes, we can!

After more than 30 years of my rising professional career, I can say, with no doubt, that true passion and professionalism have no gender, and focusing on our goals and dreams helps us to overcome gender and cultural boundaries. *Women Spacefarers* is therefore a book for everyone, for each and every one of us who wants to understand and believe that, yes, we can! We can follow our dreams, we can help others to do their jobs, we can believe in a better future, which will be better due also to our contribution, and this is not linked to our gender, but only to our willingness to contribute to the development of the human race. We have to keep in mind a famous sentence if we want to succeed and never give up in life, which you can find in StarCity in the Shepherd's house, when going down into the basement, which has become my preferred one: *the last easy day was yesterday!*

Simonetta Di Pippo
Director of the United Nations
Office for Outer Space Affairs
(UNOOSA)

Simonetta Di Pippo is the Director of the United Nations Office for Outer Space Affairs (UNOOSA). Her experience includes serving as Director of the Observation of the Universe at Agenzia Spaziale Italiana (ASI) (2002–2008) and Director of Human Spaceflight of the European Space Agency (ESA) (2008–2011). Prior to her appointment at UNOOSA in March 2014, she was Head of the European Space Policy Observatory at ASI Brussels.

Ms. Di Pippo holds a master's degree in Astrophysics and Space Physics from University "La Sapienza" in Rome, and an Honoris Causa Degree in Environmental Studies from St. John International University in Vinovo. Ms. Di Pippo was knighted by the President of the Italian Republic in 2006. In 2008, the International Astronomical Union (IAU) named asteroid 21887 "Dipippo" in honor of her contribution to this field.

Preface

Women in Space: A Soviet Record

"Hey sky, take off your hat, I'm coming!" So shouted the euphoric Valentina Tereshkova, the first Soviet cosmonaut, while blasting off from Baikonur to begin her ride to the stars, at 12:29 on June 16, 1963, when, at the height of the Cold War, the requirements for the missions were dictated by the state propaganda: what was important was to be the first in everything and at any cost. Her 49 orbits around Earth had huge media coverage and she became an instant celebrity throughout the world and the new symbol of the Soviet space progress.

It took 19 years to see another woman flying in space, and once again it was a Soviet female cosmonaut: Svetlana Savitskaya.

Once more—in the late 1970s' progressive deterioration of East–West relations—political scenarios played an important role, together with the will to excel of the Soviet Union, needing to reaffirm their superiority in space at a time when the USA had launched the new Shuttle program and rumors began to circulate that NASA had opened to women and was selecting the first female astronauts.

As Sally Ride, in April 1982, was assigned to her first Shuttle mission scheduled for the following year, the name "Svetlana Savitskaya" almost magically appeared in the crew of the Soyuz T-7. The launch of the Soyuz was planned in August, and so Svetlana would fly before Sally Ride.

As in the days of the Cold War, the competition engaged in between the two superpowers was reflected even in space. Again, the Soviets arrived first and overshadowed the pre-announced flights of the six female "Shuttlenauts."

Propaganda played a role even in the second assignment of Savitskaya to Soyuz T-12, as David Shayler and Rex Hall outlined.[1] Her appointment was in fact announced in December 1983, 3 weeks after NASA had officially announced the crew of the STS-41G mission, with Kathy Sullivan performing the first "spacewalk" by a woman. In the same

[1] Shayler, D.J.; Moule, I. *Women in Space—Following Valentina*, p. 219. Springer/Praxis Publishing, Chichester, UK (2005).

mission, even Sally Ride would fly—the first American astronaut on her second mission in space. Valentin Glushko—the former designer of rocket engines, who at the time headed the Soviet space agency—immediately decided to assign Savitskaya again and to schedule her extravehicular activity (EVA). Thus, he managed to beat once again the Americans in sending a female Soviet cosmonaut who, at the same time, was on her second venture into space and performed an EVA. To carry out his "women in space" program, Glushko had to fiercely fight against Georgi Beregovoij, the director of the Cosmonaut Training Center in Star City, who suddenly stepped in twice, using his authority to end the training program of the female cosmonauts. Both times, the program was restored again after an arduous struggle between Glushko and Beregovoi.[2]

The emancipation of women was a cornerstone of Communist propaganda: in all countries of the Soviet bloc, most of the women could study, work, have abortions, and divorce; women were also admitted into the armed forces (especially in aviation). And this is perhaps the key point. This inclusion of women in the armed forces (who ran the Soviet space program) was the bridge that allowed, in the pioneering era, the admittance of a woman into the Soviet space program well in advance of their American competitors: women in aviation were in fact well established in Russia following World War II.

Despite this, however, the Soviet Union failed to build on that promising start and, in more than 50 years, of the 20 women who have trained as Russian or Soviet spaceflyers, only four followed Valentina and went into space.

During the debate following a crowded conference that I attended in Berlin in 2013—for the celebration for the 50th anniversary of the mission of Tereshkova—in response to the question of why, after sending the first woman to orbit Earth 50 years ago, Russia has sent so few women into space, Russian cosmonaut Vladimir Kovalyonok jokingly replied that Russian spacecrafts hadn't as many places as the American Shuttle and, after all, space is a man's affair. The joke—which is still recurring—says a lot about the views of two worlds that continue to be distant from each other.

The Soviets had always accepted, even depended on, women in the workplace. But acceptance did not necessarily mean respect, much less equality. The Soviet reluctance to fly women had probably also to do with competition for slots. There have always been fewer cosmonauts than astronauts and fewer seats to fill. With only Soyuz, the cosmonauts understandably did not want to relinquish their few places to women.[3]

"Sexism has played an important role in limiting the number of Russian female cosmonauts," said Elena Dobrokvashina[4] in an interview with the Russian agency, RIA Novosti, on the occasion of the celebration of the 50th anniversary of the flight of Tereshkova. In the 1980s, Dobrokvashina was selected to train as a cosmonaut along with Svetlana Savitskaya and had followed the same training program all the way but never had the chance to fly in space. She says:

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[2] Gibson, K.B. *Women in Space: 23 Stories of First Flights, Scientific Missions and Gravity-Breaking Adventures*, pp. 45, 59–60. Chicago Review Press, Inc., Chicago (2014).

[3] Kevles, T.H. *Almost Heaven: The Story of Women in Space*, p. 137. The MIT Press, Cambridge, MA, and London, UK (2006).

[4] Interview by Makarov, A. "Sexism Limited Female Space Flights," *en.ria.ru* (RIA Novosti, June 14, 2013).

> The Russian cosmonauts are scared that if women were to go into space their aura of heroism would be lost. It's part of our mentality. Although they always say that everyone—men and women—is equal, it's no secret that we live in a man's world, where high-profile professions are reserved to them.

The chronicles of the time were filled with the resistance that the highly decorated cosmonaut Valeri V. Ryumin—veteran of three Soviet flights, in space for 362 days—opposed to the space missions of his young wife, Elena Kondakova.[5]

Right Stuff[6] but Wrong Sex

The story of the Mercury-13 shows that, although the cultural context was very different in the 1960s, the time wasn't ripe for women in space in the USA either, and enabling gender-independent access to the final frontier was a long process that would take a couple of decades.

During World War II, it seemed that *force majeure* had opened new spaces for women when they were called to replace in their daily tasks the men who had gone to the front. But these spaces shut again after the war when the situation returned to normal.

Despite that, at the turn of the 1960s, 13 talented American women pilots successfully underwent—more or less in secret—the same tests as the original Mercury-7 went through (and in some cases also outshined and outperformed the male astronauts—68 % of the women passed with "no medical reservations" compared with 56 % of the men) and, despite their excellent credentials (Jerrie Cobb, who had started flying at 12, had logged 10,000 h piloting a huge variety of aircraft, twice that accumulated by John Glenn, the most experienced Mercury astronaut), for NASA, the social role of the woman was the one firmly assigned by a consolidated stereotype masterfully represented by *LIFE* magazine that had the exclusive rights on the astronauts and their families: the woman was to take care of the house and look after the children, quietly awaiting the return of her astronaut husband.[7]

The fact that the 13 women—known today as "Mercury-13"—never had (or agreed to have) a common denomination contributed for a long time to their media (and historical) invisibility. The name itself, "Mercury-13," was suggested only in 1995 by the Hollywood producer, James Cross.[8]

Although some of them knew each other, they never met all together. Most had never even met before 1986 when one of them, Beatrice Steadman, convened them to celebrate their 25th anniversary. Not all of them came. In 1994, another of the "Mercury-13," Gene Nora Jessen, a former president of "Ninety-Nine," the international organization of women pilots, tried again. This time, it was to celebrate an important event: the fact that a woman, Eileen Collins, was appointed by NASA as first pilot astronaut—actually the first

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[5] Kevles, *Almost Heaven*, pp. 148–149.

[6] This expression became common saying after the publication of the successful book *The Right Stuff* in 1979, in which Tom Wolfe celebrated the famed Mercury astronauts.

[7] Kevles, *Almost Heaven*, p. 47.

[8] Shayler and Moule, *Women in Space*, p. 92.

woman to pilot the Space Shuttle. Nine of the 13 arrived, and 7 of them attended the Kennedy Space Center for her first launch the following year. Eight came 4 years later, in July 1999, to witness her departure when Eileen became the first commander of a spaceflight.[9]

In the early 1960s, America was gripped by space fever. The news that women were undergoing astronaut tests leaked soon. In a conference held in August 1960 at the Space and Naval Medicine Congress in Stockholm, Dr. Lovelace presented a paper on the performance of the award-winning pilot Geraldyn "Jerrie" Cobb, arguing that "females require less oxygen than the average male, and women's reproductive organs, being internal, are less vulnerable to radiation." This last point resounded promisingly to the assembled physicians as, in 1960, many people were sensitive to the issue of radioactive fallout from nuclear testing.[10]

The news immediately spread and, in the USA, the *Washington Post* ran a story entitled "Women qualifies for space training" on August 19, 1960. Jerry Cobb became an instant celebrity. In their stories, reporters called her everything: astro-nette, feminaut, astronautrix, space-girl,….[11] The term "astronaut" apparently carried such a masculine connotation that even a potential female candidate for space travel required the coining of a new label.[12]

In mid-1961, two Americans had flown in space, in ballistic flights of only a few minutes each. It was too little to seize on what was really important from a physical point of view. So candidates had to endure every possible test, even the most uncomfortable. Donald Kilgore, who was conducting the tests at the Lovelace Clinic, reported that women performed very well, and that they complained far less than their male colleagues did: "Women are more tolerant of pain and discomfort than men."

But the excitement was suddenly toned down when, in September 1961, 2 days before most of them were scheduled to start their final tests in the military naval base of Pensacola, a telegram from Lovelace arrived—like a cold shower—suspending all tests with immediate effect.

Despite Janey Hart, one of the "Mercury-13," being the wife of the powerful senator from Michigan and Jerrie Cobb, the first and only female astronaut candidate to successfully complete all the tests, knowing many of the big names in government, they didn't succeed in making contact with President Kennedy. Cobb managed, however, to meet with Vice President Johnson, who, in the late 1950s, had pushed the space race. As she later reported in an interview, Johnson, with some embarrassment in the end, shared with Jerrie:

> If we let you or other women into the space programme, we have to let black in, we'd had to let Mexican American in, we have to let every minority in, and we just can't do it.[13]

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[9] Bush Gibson, *Women in Space*, pp. 10–11.

[10] Kevles, *Almost Heaven*, p. 11.

[11] Bush Gibson, *Women in Space*, p. 21.

[12] Weitekamp, M.A. *Right Stuff, Wrong Sex: America's First Women in Space Program*, p. 78, Johns Hopkins University Press, Baltimore, MD (2006).

[13] "Women Astronaut Predicted," *New York Times* (June 26, 1962), quoted in Bush Gibson, *Women in Space*, p. 33.

Mercury-13

It was a program almost ambiguous and covert, started on the initiative of some researchers in the Lovelace Foundation who had carried out the medical tests for the selection of the Mercury candidates. Twenty-five female pilots in 1961 went through many of the same three-phase tests (physical, psychological, and space simulation) as the Mercury astronauts.

Scientists regarded women with interest, since they are smaller and lighter than men, weigh less, and breath less oxygen, and they speculated that they might make good occupants for cramped space vehicles. Thirteen out of them passed the exams and were then named "Mercury-13," as they were selected immediately after the original Mercury-7 astronauts.

The project was far from being sponsored by NASA or having any official status, and all was based on a "bootleg" effort: it was the private project of a few of the medical experts—who had tested the Mercury astronaut candidates—hinting that, if women did especially well, then NASA might consider some of them as candidate astronauts.[14]

In fact, this wouldn't even cross the mind of NASA managers. First of all, social attitudes of the time weren't favorable to the introduction of women in the space program and, mostly, NASA had already made some basic decisions that—for other reasons entirely—required astronauts to have quite specific qualifications. After preparing a draft public tender to recruit the first astronauts, NASA had second thoughts and, with the approval of President Eisenhower, decided to select candidates of the Mercury program from among the military test pilots.

Spaceflight, especially in the Mercury spacecraft, clearly wasn't going to be much like flying an airplane. But *test pilots* in particular were already doing vaguely similar work: risky testing of new high-tech vehicles. They were physically fit; they already had NOS security clearances; many of them had strong engineering backgrounds. And, most importantly, there were only a few hundred active-duty military test pilots and the first pass of selection could be done by just going through their military records. This looked a *lot* easier than sorting through thousands of applications from the public. At the end of 1958, President Eisenhower approved this pragmatic change of plans. At that time, there were no female military test pilots, so the question of whether to accept women as astronauts never even came up. The good test results obtained in the private and secret project of the Lovelace Foundation meant nothing; the exclusion of women from the early space program was mostly an accidental side effect of NASA's selection criteria: the female pilots didn't qualify and the issue simply could not arise, and never ever came up. The "Mercury-13 Program" never involved NASA and, in NASA's History Program, is referred to as "Lovelace's Woman in Space Program."[15]

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[14] Spencer, H. "Why NASA Barred Women Astronauts," *newscientist.com* (October 8, 2009).

[15] *http://history.nasa.gov/flats.html*.

And, when the medical testing started to attract too much media attention, pragmatically, the project was abruptly ended. Realistically, it was going nowhere anyway. In that context, it was unlikely that NASA could accept a female astronaut as equal partners to the male astronauts. And also the political token of launching the first woman in space was far from NASA's vision. That idea never got very far and died completely when the Soviets beat NASA by launching Valentina Tereshkova in 1963.

As later groups of astronauts were recruited for Gemini and Apollo, the criteria were loosened up, but the choice of military test pilots as the first astronauts had set the pattern. After all, nobody thought that launching the *second* woman in space was a worthwhile political gesture.

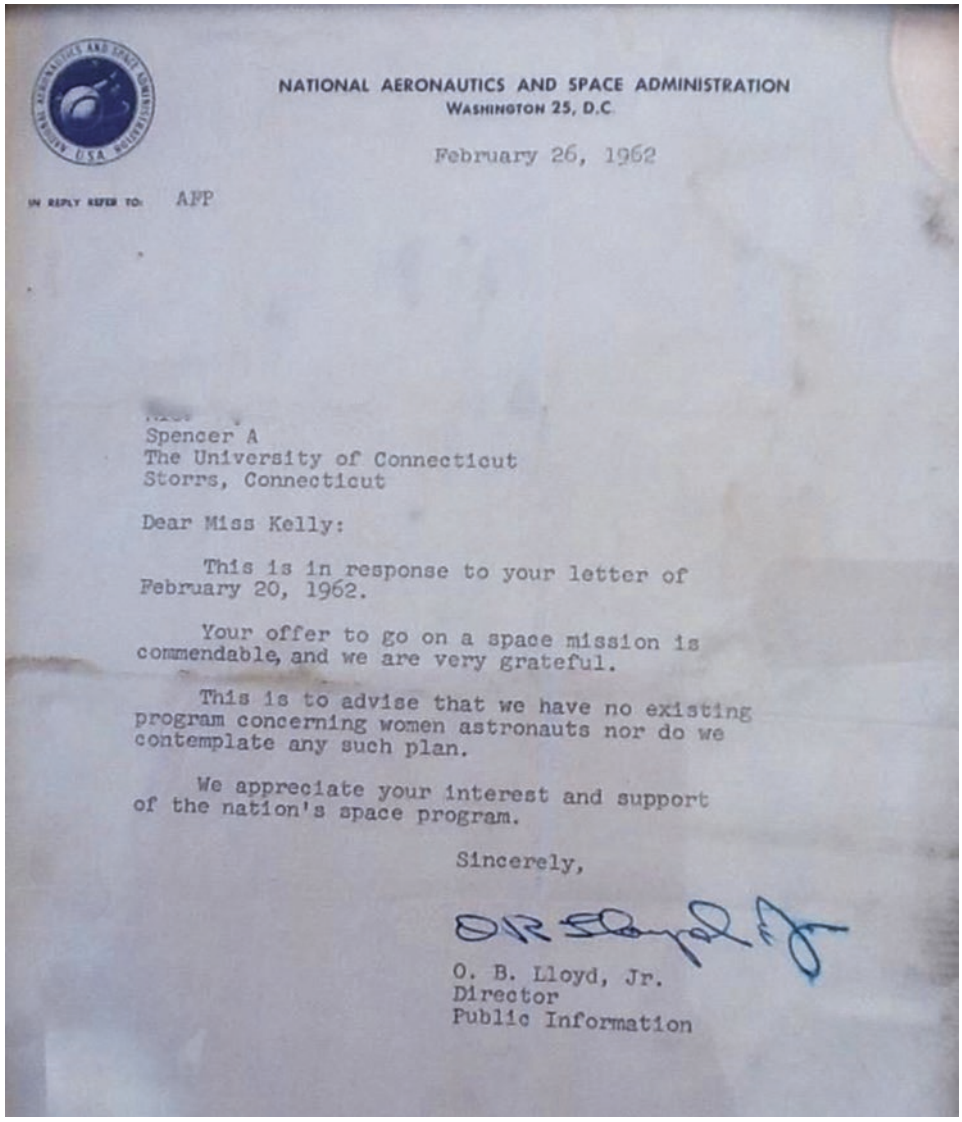
In the subsequent selections of "scientists–astronauts" of 1965 and 1967, no gender requirement was explicitly indicated. Applicants were, however, informed that they had to attend a US Air Force jet pilots training course (USAF opened to women only in 1976). A few women applied, but were rejected in the preselection phase and, again, the problem did not arise.

FLATs (Fellow Lady Astronaut Trainees)

Until the late 1970s, NASA had always refused to consider the idea of including women in the space program. The original decision of Eisenhower to choose the astronauts from the ranks of the best military test pilots had definitely excluded women and included only a small minority of white men, without worrying whether this would threaten some basic principles of democracy. Many complained that, by setting aside the "Mercury-13" operation, America had missed an incredible opportunity. As a matter of fact, although some of the Edwards best test pilots—proud soldiers with crew cuts—in their arrogance, were reluctant to become "spam in a can" in a Mercury capsule, the first 73 astronauts selected between 1959 and 1967 were military or former military, typical WASPs (White Anglo-Saxon Protestants) and the space program remained a men's club "with the right stuff."

At that time, women could not fill the roles that they cover today in the US armed forces, and this is why they had not even been considered. No one, for decades, had ever questioned the role of men in space or men on the Moon, long before Armstrong set foot there. The statement of President Kennedy in 1961 solemnly pledged America to put *a man* on the Moon before the end of the decade and to return *him* safely to Earth. At the time, the issue of gender neutrality did not arise. No one objected that he had not spoken about *a person* on the Moon and had not talked about *his/her* healthy return. When people thought about astronauts, they simply thought of men, and perhaps WASPs.

In 2008, a letter written on February 26, 1962 (a few days after the historic mission of John Glenn), by O.B. Lloyd—who was NASA Director of Public Information from 1961 to 1979—popped up on the *Reddit.com* Web site in response to a letter from an unidentified "Miss Kelly" of the University of Connecticut. In a few words, he bluntly says that NASA had no place for women: "Your offer to go on a space mission is commendable and we are very grateful. This is to advise that we have no existing program concerning women astronauts nor do we contemplate any such plan."



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON 25, D.C.

February 26, 1962

IN REPLY REFER TO: APP

Spencer A
The University of Connecticut
Storrs, Connecticut

Dear Miss Kelly:

This is in response to your letter of February 20, 1962.

Your offer to go on a space mission is commendable, and we are very grateful.

This is to advise that we have no existing program concerning women astronauts nor do we contemplate any such plan.

We appreciate your interest and support of the nation's space program.

Sincerely,

O. B. Lloyd, Jr.
Director
Public Information

"Letter to Miss Kelly." This rejection letter sent by NASA in 1962 was first published on *www.reddit.com* in July 2013

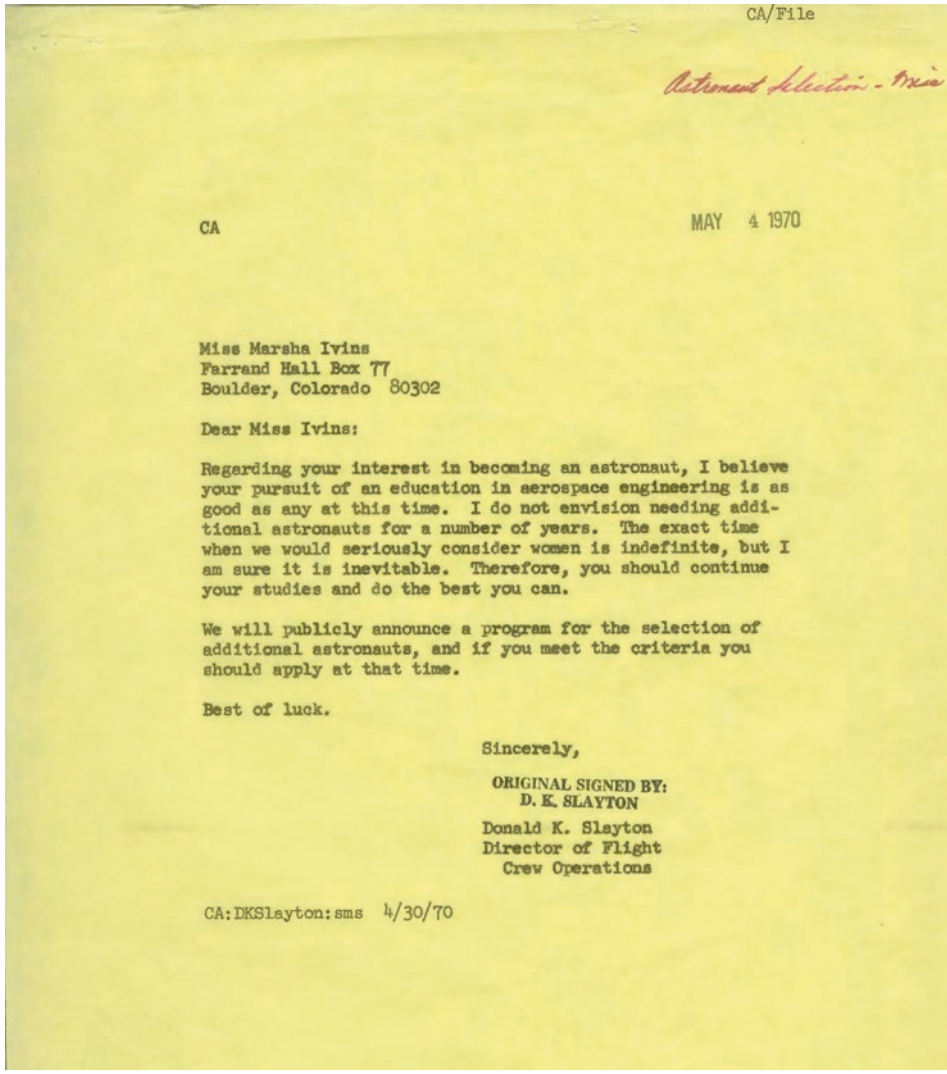
Only 16 months after this rejection, the USSR gave the USA a more resounding slap and grasped another record: after sending the first man into space, they sent also the first Soviet woman, Valentina Tereshkova, into space.

Hillary Clinton, during her presidential campaign of 2009, claimed that she had received from NASA a similar rejection letter (although it has been highlighted that there is no record of such letter, and the political context in which this claim was disclosed would legitimize some doubt).[16]

[16] Oberg, J. "'We Don't Take Girls': Hillary Clinton and Her NASA Letter," *thespacereview.com* (June 10, 2013).

Traditionally, in the USA, women could at most work as teachers, nurses, or secretaries, without aspiring to important positions, and were almost totally excluded from the "STEM careers," dealing with science, technology, engineering, and mathematics.

The attitude of NASA had, however, to change, albeit very slowly. Already, in 1970, Deke Slayton, the legendary "indecipherable" boss of the Astronaut Office, wrote to Marsha Ivins, who a long time after would become an astronaut herself (see Chap. 14 on Marsha Ivins): "I do not envision needing additional astronauts for a number of years." And, in this, he was right: the next selection was made in 1978. He added: "The exact time when we would seriously consider women is indefinite, but I am sure it is inevitable."



CA/File

Astronaut Selection - Misc.

CA MAY 4 1970

Miss Marsha Ivins
Farrand Hall Box 77
Boulder, Colorado 80302

Dear Miss Ivins:

Regarding your interest in becoming an astronaut, I believe your pursuit of an education in aerospace engineering is as good as any at this time. I do not envision needing additional astronauts for a number of years. The exact time when we would seriously consider women is indefinite, but I am sure it is inevitable. Therefore, you should continue your studies and do the best you can.

We will publicly announce a program for the selection of additional astronauts, and if you meet the criteria you should apply at that time.

Best of luck.

Sincerely,

ORIGINAL SIGNED BY:
D. K. SLAYTON

Donald K. Slayton
Director of Flight
Crew Operations

CA:DKSlayton:sms 4/30/70

Marsha Ivin's letter from Deke Slayton. This letter was found in the JSC History Collection, UHCL Archives (University of Houston-Clear Lake), and was first published on *neumannlib.blogspot.it* in October 2011. The Letter was in reply to the letter by Marsha Ivins reproduced at page 102

And he concluded: "We will publicly announce a program for the selection of additional astronauts, and if you meet the criteria you should apply at that time."

Every Country Has Its Own Astronauts

The term "astronaut" derives from the Greek words *ástron* (ἄστρον), meaning "star," and *nautes* (ναύτης), meaning "sailor." The first known use of the term "astronaut" was in *Voyage dans la Lune* (*Journey to the Moon*, 1657) by French poet, Cyrano de Bergerac (1619–1655).[17] The term is referred to as a spacecraft in the science fiction novel *Across the Zodiac* by Percy Greg (UK, 1880). In the modern sense, it is found in *Les Navigateurs de l'Infini* by Josephi Henri Honoré Boex (Belgium, 1925). The word may have likely been inspired from the novel *Auf Zwei Planeten* (*On Two Planets*) by the German philosopher and writer, Kurd Laßwitz, who, in his 1897 science fiction novel, refers to the first encounter with the highly advanced Martian civilization. The term itself may have originated from "aeronaut," an older term for an air traveler, which was first applied to balloonists in 1784. An early use in a nonfiction publication is Eric Frank Russell's poem "The Astronaut" published in November 1934 on the *Bulletin of the British Interplanetary Society*. The term was used liberally during the infancy of the rocket plane, as in a *New York Times* article that opens with this sentence: "Evidently the astronauts who dreamed of kicking themselves from the Earth to Mars were not mad."[18] The term entered then into the official name of the International Astronautical Federation, which, since 1950, has held its yearly International Astronautical Congress.

The term made its fortune when, at the beginning of the 1960s, it was adopted by NASA and eventually by the European Space Agency (ESA), though at the beginning it wasn't welcomed very much by the "Mercury-7" astronauts who—themselves test pilots—had preferred the term "spacecraft pilot." According to journalist James Scheftern,[19] the name was picked by Bob Gilruth (the first director of NASA's Manned Spacecraft Center, later renamed the Lyndon B. Johnson Space Center).

The Russians diversified also in this respect from American competitors and, when designing their space explorer, they coined their own term—"cosmonaut" (*Космонавт*), where the word космос (from Greek κόσμος) has a wider meaning encompassing the concepts of "universe," "order," and "organization." While "stars" are loaded up by classical Western mythology with references to "divine" and "celestial," the Soviet космос, laical, and Communist refers to the order of the universe.

To refer to a Chinese space explorer, in the West, we use the phrase "taikonaut": a hybrid expression indeed putting together the Greek word *nautes* and the Chinese

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[17] Wells, H.T.; Whiteley, S.H.; Karegeannes, C.E. "Origin of NASA Names," The NASA History Series, SP-4402, Washington (1976), p. 200.

[18] "The Rocket Plane Is Here," *New York Times* (January 8, 1944), 12—quoted in Dickson, P. *A Dictionary of the Space Age*, pp. 26–27. Johns Hopkins University Press (2009).

[19] Quoted in *ibid.*, at p. 27

tàikōng (meaning "space"). It was first used in 1998 by a Malaysian newsgroup. In Hong Kong and Taiwan, 太空人 (*tài kōng rén* meaning "spaceman": a concept very similar to "astronaut") is often used. This word isn't, however, used in China, where they prefer instead the term 航天亮 (*háng tiān yuán* meaning "space navigating personnel") when referring to Chinese space travelers and the term 宇航亮 (yǔ háng *yuán*, with very similar meaning) when they refer to American astronauts or Russian/Soviet cosmonauts.

While no nation other than the Russian Federation (and previous Soviet Union), the USA, and China has launched a manned spacecraft, several other nations have sent people into space in cooperation with one of these countries. Other synonyms for "astronaut" have entered occasional usage in the different countries. In France, for example, the term *Spationaut* or "space sailor," encapsulating the Latin term *Spatium*, is often used.

It is easy to predict that, in the future, yet more terms with similar meanings will appear, such as the term *Vyomanaut*—coined from the Sanskrit word for space—that has already begun circulating in India.

The media have occasionally used terms like "Austronaut" during the flight of Franz Viehböck, the first Austrian astronaut, or "Afronaut" during the flight of Mark Shuttleworth, the South African billionaire who was the first astronaut from the Black Continent.

With the rise in space tourism, NASA and the Russian Federal Space Agency agreed to use the term "spaceflight participant"—which was applied for the first time for the "Teacher in Space" mission—to distinguish the profile of those space travelers from professional astronauts. The same name was eventually adopted even by Russians, who translated it as Участник космического полёта (*učastnik kosmičeskogo polyota*).

In the USA, a candidate becomes an "astronaut" after completing 20 months of basic training, while, in Russia, he/she becomes "cosmonaut" after his/her first successful spaceflight. It is the same in China.

NASA Opens to Women

Although NASA was formally established as a civilian agency, it suffered an internal conflict with its military roots from the beginning. Not only were the astronauts military, but many of the administrative and technical staff and their bosses were also military or former military; the language was military (astronaut goes "in mission") and the command chain was military. Also, the organization and habits were borrowed from the military world.

The US Navy began to accept women for their first pilot training courses in 1974. The US Air Force opened up to women 2 years later, in 1976, although they didn't accept women for the test pilot career until 1988.

After the opening of aviation to women, even NASA threw in the towel. On the other hand, in the new Shuttle scenario, the needs were changing and not only fighter pilots were required. A new type of astronaut was introduced: the mission specialist, who was a researcher with a deep technical and scientific background. At this point, there wasn't a

reason to keep women away, also because, in the second half of the 1970s, the percentage of women with tech/sci university education had significantly grown. In its 1977 call for astronauts, 10 years after the previous one, NASA—overcoming quite a lot of internal resistance—finally opened the Astronaut Corps to women.

One of the hardest opponents to the new policy was Chris Kraft, the Director of Human Flight at the NASA Marshall Space Center in Houston. The authoritarian Chris Kraft, for better and for worse, had been, together with the impenetrable Deke Slayton, one of the stars of the NASA golden age in the days of Mercury, Gemini, and Apollo, and was the architect of the Mission Control Center.[20] And, ironically, it just happened to fall to him to manage the new deal and to pave the way for the entrance of women into NASA.

In response to the much-anticipated announcement for new astronauts, at NASA headquarters in Washington, they expected to get a flood of applications from female candidates but, after 6 months, only 93 had arrived. Until then, at every astronaut public appearance, people wondered why the space program didn't include also women and minorities. Now that NASA wanted to recruit them, the women and minorities seemed to have vanished. It was embarrassing: the public, and especially the women, had lost interest in the space program. The headquarters asked Kraft to develop a plan to recruit women and minorities. He had to establish an Astronaut Selection Board. The first suggestion he got from this committee was "not to ask female candidates questions that were not asked to men," especially questions about their marital status or family plans: the tactics of recruitment were targeted by feminists.

The committee sent thousands of letters to various public agencies, to university faculties, and to technical and scientific associations, especially where female scientists and engineers worked. He also asked for the help of Nichelle Nichols, the successful Afro-American actress who had played Lieutenant Uhura in *Star Trek* and, to publicize the new campaign, NASA awarded US$49,900 to her production agency, Women in Motion. After 6 months, 8000 additional applications had arrived, including 1000 from women.

And, from there, NASA selected, for the first time, six women to be integrated into its Astronaut Corps.

When the women arrived at NASA, the Mercury astronauts were gone, but still there were several Gemini and Apollo astronauts and crowds of girls running after them as if they were movie stars. The women found a different welcome. There weren't crowds of boys behind them. The fatal attraction that astronauts practiced on girls did not work with the female astronauts with respect to the boys, who seemed rather to suffer from what Mary Cleave called "PWS" (Professional Women Syndrome): men who were not astronauts saw them as unapproachable and were frightened.[21]

The women found it easier to socialize with their fellow astronauts. But not all. Some astronauts of the old guard greeted them well, while others saw them with annoyance. Rhea Seddon says:

> They thought we would not be able to do things well and thought we occupied the place that could occupy some other guy. On the other hand, some did not even know well how to deal with women who came to be at their same level.

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[20] During the NASA golden age, as head of the Mission Control Centre, Chris Kraft played an important role in deciding who would not fly anymore. The exclusion of Carpenter from future missions and of the entire crew of Apollo 7 was attributed to him, as reported by Walter Cunningham in his book *The All-American Boys*, p. 191. iBooks, Inc., New York (2004).

[21] Kevles, *Almost Heaven*, p. 71.

The first six women astronauts selected by NASA. From left to right: Shannon Lucid, Rhea Seddon, Kathy Sullivan, Judy Resnik, Anna Fisher Fisher, and Sally Ride. Credit: © NASA

At first, the newcomers also had to face the hostility of the old astronauts' wives. They were military wives who had accepted—as part of their status—to stay in the background and play a supporting role. When Patricia Collins, wife of Michael Collins, was offered by a local newspaper to write a regular column, NASA recommended—or rather, ordered—her not to accept. These wives were threatened by the presence of the women who would train with, work with, and fly with their husbands, at the same level (considering also the reputation of being unruly that always had accompanied some of them).[22]

Also, NASA management found it hard to deal with the new issues. Rhea Seddon, the first astronaut to become pregnant, recalls when she went with her husband, fellow astronaut Hoot Gibson, to announce the news to her bosses:

> I didn't want to be held back on jobs or flight assignments. We went to tell the chief of the Astronaut Office. John Young, and he didn't seem to know what to say except congratulations. We talked to Mr. Abbey, the head on Flight Operations, and got his usual taciturn response. We decided there might be outside questions about it, so we

[22] One of the most realistic and truthful testimonies of the atmosphere at the NASA Astronaut Corps during the Gemini and Apollo era is found in the aforementioned book by Walter Cunningham, *The All-American Boys*, which was judged by *Los Angeles Times* as "the best of all astronaut books."

also talked with our friend and Center Director Dr. Chris Kraft. He seemed pleased and comfortable with my continuing my current career path. We left their offices feeling like: "No sweat, they aren't worried." Almost before I could get back to my office, my phone started ringing. The Flight Medicine Clinic called to tell me no more T-38 flying if I was pregnant.[23]

The Long Road to Integration in the East

Leaving for Star City in the early 1990s to train for the Shuttle–Mir program, Americans noticed a cultural division between Russian men and Russian women that reminded them of what had happened in the USA a generation before.

On board Mir in the 1990s, there wasn't great gender discrimination between Russian men and foreign women, but there was, however, a marked division between Russians: males—rightly or wrongly—never had a great concept of their female cosmonauts.

Cosmonauts at Star City preferred not to comment on the performance of Tereshkova, whom they felt was an embarrassing case. On the other hand, Glushko himself had done everything to keep her away from the active scene. When, in 1974, Glushko—already an honorary member of the powerful Central Committee of the Communist Party—had taken the reins of NPO Energia, he wanted to overthrow the Soviet policy on women in space. In search of new records, he wanted to have an only-women crew and started a complex selection of ten candidate female cosmonauts. But he did not want to have to deal either with Valentina or with any of her group again. To avoid any misunderstanding, he lowered the maximum age requirement to 33 years. "Tereshkova," he diplomatically asserted, "is a national asset; flying into space is risky. We must protect her. It's better that the risk is taken by someone else."

On her part, Tereshkova, who wanted to go into space herself, never showed any sympathy for the new class of female cosmonauts; she never paid them a visit during their training or attended the launch of one of them, Svetlana Savitskaya, "due to illness"—the official reason for her absence.

At Star City, they even remembered conflicts between Svetlana Savitskaya and his Salyut 7 colleagues and disagreements between Elena Kondakova and the Mir crew.

Before Elena Serova's mission, out of 19 female cosmonauts who had completed all of the hard training, only three could actually fly in over 50 years. The Soviet program did not have a great concept of female cosmonauts.[24]

Nor did the Soviet female cosmonauts appreciate each other that much. We have already mentioned the relationship between Savitskaya and Tereshkova. Also, Elena Kondakova is very judgmental with regard to Svetlana Savitskaya, whom she condemns for her "typical American attitude" and for her determination to do everything a man could do on the International Space Station (ISS)—an "attitude that caused much misunderstanding on MIR." Kondakova says:

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[23] Seddon, R. *Go for Orbit*, p. 133. Your Space Press, Murfreesboro, TN (2015).

[24] Pultarova, T. "Much Ado about Liu Yang," *spacesafetymagazine.com* (June 21, 2012).

> In summary—strong personality but lack of diplomacy. Savitskaya is a good pilot and a good engineer. Nothing to complain about her technical expertise. But when working with men was a typical case of 'diamond cut diamond'. She wanted to have more responsibilities than men were willing to grant her. One of the most important things in space is to be able to find a compromise.[25]

The Soviet cosmonauts used to treat their women in one way and foreign women—whose countries had paid for the trip—as anyone would treat valued customers. Or at least that's how it happened in space. On the ground—in Star City—more than one experience was not exactly comforting. Dunbar, suddenly thrown into a culture light years away, experienced at first hand the aversion of the Russian space environment against women. She hung in there for over 1 year. At the final party held at Star City, she remembers:

> Jurij Kargapolov, the head of training there, who had been in charge of training and had been hardest on me in the previous twelve months, got up and, looking at me, devoted me a toast for my perseverance. Then General Genibechov came up to me afterward and said 'You know, you American women are tough! We would like to have you fly a long-duration mission with us anytime!' … I was glad because, apart from anything else, I had done what I had set to do, which was to finish my job, graduate with… and who knows maybe they would think a little bit differently even about women in their program![26]

Full Integration in the West

In a little more than 50 years, a total of 60 women have ventured into space, and they represent about 10 % of the total of 552 space travelers (according to the United States Army Ground Forces (USAGF) definition, as of April 2016).

Today, in the Western world, a woman in space has become almost routine—inasmuch as confrontation with a hostile and risky environment like the space may be considered "routine." They are now fully integrated as ordinary members of this out-of-the-ordinary club that is the Astronaut Corps.

Pilots, doctors, scientists, engineers, single, married, divorced, mothers—all try to reconcile the demands of work with those of families, sometimes succeeding well, sometimes having a hard time, more or less as happens to everybody. Payload Specialist, Mission Specialist, Flight Engineer, Pilot Commander, Mission Commander, Head of Astronaut Office: there is no position that NASA female astronauts haven't occupied in the recent years, both in the Space Shuttle and on the ISS, and also on Earth in the NASA organization.

And, even now that, after the end of the Shuttle era, the number of astronauts has again decreased, when a woman leaves for a mission, her name is just mentioned along with the other colleagues, as an "astronaut," not as a "woman astronauts." The departure of a

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[25] Kevles, *Almost Heaven*, pp. 148–149.

[26] Interview with Bonnie Dunbar, "Oral History," *nasa.gov* (June 16, 1998).

woman for space doesn't make headline news anymore. And this means that now their integration in the space program has completely taken place.

Men and women work together on the ISS with interchangeable roles: no difference in training, or in the operation, or in responsibility.[27]

Six American female astronauts have flown in space five times: Shannon Lucid, Bonnie Dunbar, Marsha Ivins, Tamara Jernigan, Susan Helms, and Janice Voss, who recently passed away. It is actually a record, especially if we consider that the American female astronauts began to fly in space just 30 years ago and that the overall record of flights in space, held by the two American astronauts Jerry L. Ross and Franklin Chang-Diaz, is seven space missions.

Susan Helms holds the record for the longest spacewalk in history (8 h and 56 min), while Peggy Whitson—who was the first female Commander of the ISS and is considered by NASA the most experienced woman astronaut—holds the record for a female astronaut in zero gravity, having spent, over two long-duration missions on the ISS, more than 1 year of her life off the planet: in fact, over 376 days (a record that will be soon surpassed as she has been assigned to a new long-duration mission on the ISS). She is closely followed by Sunita Williams, who has spent a total of over 321 days in space and also holds the record for the number of spacewalks performed by a woman, with seven EVAs and 50 h spent in open space.

Women have also paid heavy costs, with four female astronauts as victims in the two tragedies of *Challenger* in 1986 and *Columbia* in 2003—four exceptional life stories broken. Christa McAuliffe, the legendary "Teacher in Space,"[28] and the "veteran" Judith Resnik, who was the second American in space and the first American Jewish astronaut, lost their lives in the disaster of the Shuttle *Challenger* STS-51L, which exploded 73 s after launch. Two more died tragically in the Shuttle *Columbia* STS-107, which disintegrated over the skies of Texas during re-entry at the end of a fruitful scientific mission of 16 days in space. They were Kalpana Chawla, the first Indian astronaut, in her second spaceflight, and Laurel Clark, Medical Officer of the US Navy, who had been initially assigned to a mission on the ISS that would lead her to becoming the first woman on a long-term mission and was then diverted to this fatal flight.

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[27] How men and women adapt differently to spaceflight has been investigated by NASA and NSBRI (National Space Biomedical Research Institute). A comprehensive report on sex and gender differences related to human physiology and psychology in spaceflight has been published on the *Journal of Women's Health*, November 2014, and is available online in PDF format at the Web site of the Mary Ann Liebert, Inc. publisher: *http://online.liebertpub.com/toc/jwh/23/11*. Although there is an imbalance of data available for men and women, primarily due to fewer women who have flown in space, a long list of differences is reported by the six Sex & Gender Work Groups that participated in the research. A summary of the reports can be found online at www.nasa.gov/content/men-women-spaceflight-adaptation.

[28] Strictly speaking, Christa McAuliffe should not be regarded as an astronaut because the *Challenger* that was bringing her for the first time into space exploded 73 s after launch, at a height of just over 14,500 m—long before it crossed the Kármán line. But we cannot do without mentioning her here, since, more than many of her colleagues, during her intense preparation, the "Teacher in Space" captured the imagination of the USA and of the entire world and gave a great contribution to the revival of interest in the space program.

The women who fly into space have an average age of 40 years and have a degree, typically in engineering, but many are also doctors, biologists, biochemists, or physicists. On the other hand, today, astronauts fly into space to learn, to experience, to investigate; and the most significant research contributions are expected from doctors, biologists, and physicists. Often, women astronauts have more than just one degree, although it is difficult to surpass the Canadian Roberta Bondar who, after graduating in—among others—zoology, pathology, neurology, and neurobiology, was awarded with 24 honorary degrees by US and Canadian universities. Even Claudie Haigneré—who, at 20, had already completed her university studies in Medicine—in terms of academic qualifications is not joking around, and she earned among her friends the nickname "BAC + 19" (referring to her 19 university degrees).

Many are married to an astronaut, almost perpetuating the "space marriage" of Tereshkova and Nikolayev, personally sponsored by Khrushchev for propaganda purposes.

Many are mothers. Anna Lee Fisher made history when she was the first mother to fly in space, leaving at home a daughter just a few months old: the emblem of her mission features six stars—five representing the crew and the sixth for the newborn.

Often, they are civilians, but a few are also military pilots, with impressive career records.

On the other hand, safely going to space and returning requires special skills: the return of the Shuttle, which landed like a glider, began from a speed of 17,000 miles per hour—something like four and a half miles per second!

I recently met the astronaut Kathryn Hire, who was the first American woman to be assigned to a combat aircraft and, between 2001 and 2003, she participated in the Enduring Freedom and Iraqi Freedom Operations. But this is not the only case. US Navy pilots are Susan Kilrain, with 3000 h of flight on 30 different fighter jets, and Sunita Williams, who scored 3000 flight hours and, in 1992, operated as a combat helicopter pilot in the Desert Shield Operation; not to mention Colonel Eileen Collins, the US military pilot who became the first instructor of T-38 and other high-performance fighter jets, and test pilot: she was then the first pilot of the Shuttle, on which she flew four times, and finally the first Shuttle Commander. Or Pamela Melroy, who, after participating in the Gulf War with more than 200 combat hours, also became a military jet test pilot, with a backlog of over 5000 h on 50 different types of aircraft, and joined NASA, where she became the second woman to command the Space Shuttle. Even the Italian astronaut Samantha Cristoforetti is a military pilot certified for combat.

"Female Quotas" Are Rising

NASA active female astronauts in April 2016 number 12 and account for over 26 % of the entire Astronaut Corps, totaling 46 active astronauts:[29] indeed, they constitute one in every four astronauts. The percentage is not bad if we consider that, for example, in the US Police Corps, there is 1 woman in 7, and 1 in 20 in the Air Force. With the end of the Shuttle era, the NASA Astronaut Corps sharply decreased from 149 astronauts in 2000[30] to just one-third today, but the number of women is growing. Fifty percent of the astro-

[29] See "*astrobio*" at *www.jsc.nasa.gov*.

[30] Rhian, J. "How Many Astronauts Does NASA Need?," *universetoday.com* (December 7, 2010).