



ELSEVIER

Contents lists available at ScienceDirect

Acta Astronautica

journal homepage: www.elsevier.com/locate/actaastro

Human space exploration – From surviving to performing

Gilles Clément*, Angelia P. Bukley

International Space University, Parc d'Innovation, 1 rue Jean-Dominique Cassini, 67400 Illkirch-Graffenstaden, France



ARTICLE INFO

Article history:

Received 21 January 2014

Received in revised form

13 March 2014

Accepted 1 April 2014

Available online 13 April 2014

Keywords:

Space exploration

Human spaceflight

Microgravity

Living and working in space

Spaceflight participant

ABSTRACT

This paper explores the evolution of human spaceflight by examining the space programs of the United States, Russia, including the former Soviet Union, and China. A simple analysis of the numbers of humans who have flown into space, the durations of the missions flown, and the accumulated flight time of the individuals reveals that spaceflight is decidedly male-dominated and that approximately one out of six individuals flown was a non-career astronaut. In addition, 31 individuals have accumulated long-duration flight experience equivalent to a round trip to Mars. An examination of the evolution of spacecraft that have made these missions possible indicates that the time to accomplish the first four to five flights of a new human space vehicle has increased from less than one year to nearly 10 years.

© 2014 IAA. Published by Elsevier Ltd. All rights reserved.

1. Introduction

Much has been written about human spaceflight and exploration, from its history and evolution, to the technologies that have been derived, to where humans might go in the future. The purpose of this paper is to explore human spaceflight by the numbers in an analytical fashion based on publicly available information. By looking back over the last 52 years of human spaceflight and examining the evolution of the early missions through the Apollo era up to the current work on board the International Space Station (ISS), we will examine how many individuals have been in space, and for how long, and discuss how the purpose of going to space has transitioned from simply surviving the trip to the performance of significant scientific research. We also discuss the relevance of the length of time individuals have spent in space to a human Mars mission.

Three countries have put humans into space: Soviet Union/Russia, the United States, and China. They have done

so in a progressive, step-wise approach with each mission building on the successes of the ones prior, leveraging the lessons learned along the way. The Soviet Union progressed from Vostok (1961–1963) to Voskhod (1964–1965) to the Soyuz (1967–present) while the United States began with the Mercury (1961–1963), followed by Gemini (1965–1966) and ultimately winning the race to the Moon with the Apollo (1968–1972) series of vehicles. Seven years after the end of the Apollo program, the US Space Shuttles (1981–2011) went into service. The latest series of human-rated spacecraft is Shenzhou (2003–present), which is the centerpiece of the Chinese human spaceflight program.

The Soviets and US launched the Salyut (1971–1986) and Skylab (1972–1974) space stations into low Earth orbit (LEO) in the early 1970s. The Soviet Mir space station became the Russian space station with the dissolution of the Soviet Union in 1989. The Russians maintained a permanent presence on Mir for 10 years. It was during this period that records were set for long-duration space missions. The US, Russia, Europeans, Canadians, and Japanese have joined forces on the ISS, which has been occupied over the last 13 years. The Chinese have launched Tiangong-1, a human-tended space laboratory, in 2011. Their second space laboratory is expected to be launched

* Corresponding author. Tel.: +33 3 88 65 54 44.

E-mail address: gilles.clement@isunet.edu (G. Clément).

in 2015, with 20 days of life support for a crew of three. Tiangong-3 should be launched next, with 40 days of life support. This sequence of gradual steps leads towards the eventual development of a permanent space station just as the ISS is currently scheduled to be retired.

2. Where we are

Human spaceflight began on 12th April 1961 with Yuri Gagarin's single orbit around the Earth onboard the *Vostok-1* spacecraft. Fifty-two years later, a total of 539 individuals¹ have flown beyond 100 km in altitude (where space begins, as arbitrarily chosen by the International Federation of Astronautics), which is an average of about 10 per year [1]. These individuals are called astronauts, cosmonauts (the name used in the Russian language or with respect to astronauts flown in Russian space transportation systems), or taikonauts (the name given to Chinese astronauts). A number of these individuals have flown multiple missions. In this paper we refer to a “person-flight” as a crewmember flying one mission, regardless of the mission duration or whether or not the crewmember has flown multiple times. As of 31st December 2013, the total number of person-flights is 1211.

It is interesting, or rather disappointing to consider how male-dominated the human spaceflight endeavor is. In fact, female crewmembers comprise only 10.6% of the 539 individuals who have flown in space, or 57 to be exact. Of the 1211 person-flights, only 133 of these flights were executed by female crewmembers, meaning that the overall number of female space person-flights is still less than 11% of the total. Humans have spent in excess of 117 years in space. However, the total duration of all flights for female crewmembers is only about 9 years. When compared to a human life span, the concept of women flying in space is still in its childhood.

The mean duration of all human spaceflights to date is about 56.3 days, but the distribution is not normal (Fig. 1). The median time that each crewmember spent in orbit is close to 11 days. There have been 1001 person-flights that lasted for less than 1 month. Nearly 70% of these flights took place on board the Space Shuttle during missions that lasted from 5 to 17 days. Most of the other 210 person-flights took place during long-duration missions on board space stations, including the Skylab, Salyut, Mir, and the International Space Station. Over the past decade alone, the number of person-flights ranging from 1 to 6 months has increased by 85% [2]. Since 2009, the ISS has had a permanent crew of six. Therefore, the person-flight count will continue to increase by 12 each year. When the ISS will reach the end of its lifetime, by 2020, the number of long-duration person-flights should approach 300.

Because Fig. 1 is plotted on a logarithmic scale, there are 15 crewmembers who flew over 100-km in altitude whose missions are not included in the plot because they lasted less than one day. These missions were executed on board *Vostok-1*, X-15 (2 flights), Soyuz-18A, Mercury-3,

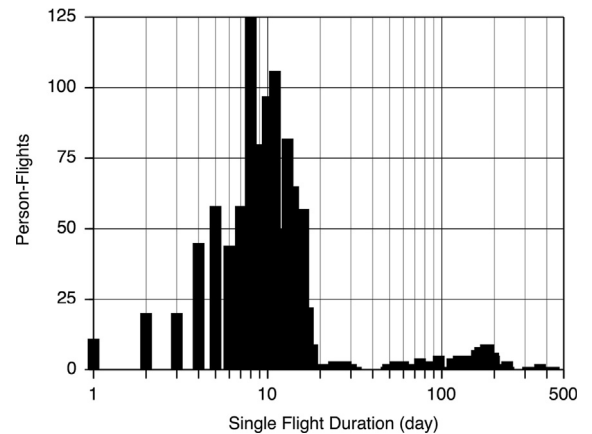


Fig. 1. Frequency distribution of the 1211 person-flights as a function of flight duration.

Mercury-4, Gemini-3, Gemini-8, Shenzhou-5, and SpaceShipOne (3 flights). Of these 15 crewmembers, nine of them flew orbital flights lasting less than one day and the other six crewmembers flew sub-orbital missions.

3. Spaceflight participants

With the development of new commercial space vehicles designed to take paying customers on suborbital, and eventually orbital, spaceflights, the number of humans traveling into space might potentially see a substantial increase in the coming years. There is a strong perception that of the 539 individuals who have traveled into space, with only a small handful of recent exceptions, all have been government employees handpicked by space agencies [3]. However, this is actually not the case. Since the late 1970s, individuals who were not part of a government astronaut or cosmonaut corps have flown into space.

The NASA definition of spaceflight participant (SFP) is any person who flies into space and does not provide a recurring service as a career astronaut [4]. These individuals typically travel on government sponsored space missions, although some pay for their flights personally or have their travel expenses covered by their company. The concept of SFP encompasses a broad range of space explorers, including payload specialists, teachers in space, government observers, the Soviet Union's Intercosmos guest cosmonauts, the Roscosmos researcher-cosmonauts, and those who will soon fly onboard commercial vehicles that are at various stages of development [4].

To date, 54 payload specialists [5], 14 guest or researcher cosmonauts, eight international space travelers who flew the so-called Soyuz taxi missions to Mir and ISS, a Japanese journalist from the Tokyo Broadcasting System, one woman from the private British consortium Project Juno, and seven space tourists who booked their flights through Space Adventures, have flown as SFPs. This means that 85 out of the 539 individuals who have flown into space, or nearly one out of six, have been an SFP, in accordance with the NASA definition. It is safe to say that this number is much higher than is currently believed.

¹ The total of 539 was reached on 25 September 2013 on board Soyuz TMA-10M.

Download English Version:

<https://daneshyari.com/en/article/1714543>

Download Persian Version:

<https://daneshyari.com/article/1714543>

[Daneshyari.com](https://daneshyari.com)