



Commercial Astronauts

The Next Generation of Spacefarers
— Erik Seedhouse —



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Erik Seedhouse

Commercial Astronauts

The Next Generation of Spacefarers



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To all the those who work with the International Institute of Astronautical Sciences, in the hope that they may experience at first hand the delights and dangers of spaceflight.

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Daytona Beach, FL, USA

Erik Seedhouse

Preface

The beginning of the 2020s witnessed dozens of commercial astronauts fly to space on a variety of vehicles that included SpaceX's Crew Dragon, which supported the Inspiration4 and Axiom Space missions, Virgin Galactic's SpaceShipTwo, which supported several suborbital science flights, and Blue Origin's New Shepard spacecraft. While the media may have focused more on the celebrities that flew, most of the spacefarers were commercial astronauts.

The story of this new breed of spacefarer has only just begun. As evidenced by these missions, commercial spaceflight has grown beyond passengers simply traveling to space just for the ride. With orbital flights involving commercial astronauts staying in space for several days and weeks, companies such as Sierra Space, Axiom Space, and Blue Origin are preparing for the next steps in commercial space travel which include the construction of orbiting habitats and eventually, in the case of SpaceX, venturing to Mars.

But how will opportunities for commercial astronauts develop, how will they be trained, and will this new group of astronauts evolve? This book describes how the commercial spaceflight industry is evolving, how it will continue to evolve as barriers to entry are reduced, competition grows, and costs are lowered, and how, because of these efforts, opportunities for commercial astronauts will increase.

Daytona Beach, FL, USA

Erik Seedhouse

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About the Author

Erik Seedhouse is a professor in Spaceflight Operations at Embry-Riddle Aeronautical University. He has extensive practical and theoretical experience in many of the subjects in this book. After completing his first degree he joined the 2nd Battalion, the Parachute Regiment. During his time in the 'Para's,' Erik spent six months in Belize, where he was trained in the art of jungle warfare. Later, he spent several months learning the intricacies of desert warfare in Cyprus. He made more than 30 jumps from a Hercules C130 aircraft, performed more than helicopter two hundred abseils, and fired more light anti-tank weapons than he cares to remember!

Upon returning to academia, the author embarked upon a master's degree which he supported by winning prize money in 100km running races. After placing third in the World 100km Championships in 1992, Erik turned to ultra-distance triathlon, winning the World Endurance Triathlon Championships in 1995 and 1996. For good measure, he won the World Double Ironman Championships in 1995 and the infamous Decatriathlon, an event requiring competitors to swim 38km, cycle 1800km, and run 422km. Non-stop!

In 1996, Erik pursued his Ph.D. at the German Space Agency's Institute for Space Medicine. While studying he found time to win Ultraman Hawai'i and the European Ultraman Championships as well as completing Race Across America. Due to his success as the world's leading ultra-distance triathlete, Erik was featured in dozens of magazine and television interviews. In 1997, GQ magazine named him the 'Fittest Man in the World'.

In 1999 Erik took a research job at Simon Fraser University. In 2005, the author worked as an astronaut training consultant for Bigelow Aerospace. Between 2008 and 2013, he served as Director of the Canadian Forces

manned centrifuge and hypobaric operations. In 2009, he was one of the final 30 candidates in the Canadian Space Agency's Astronaut Recruitment Campaign. He holds a pilot license, scuba license, and sky-diving Category A license and in his spare time works as an astronaut instructor for Project PoSSUM, an instructor for the International Institute of Astronautical Sciences, occasional film consultant to Hollywood, a professional speaker, triathlon coach, author, and science advisor to the Proteus Ocean Group. He also serves as a consultant to myriad television productions such as National Geographic and regularly ventures into the mountains – he has reached the summits of Kilimanjaro, Aconcagua, Elbrus, Rainier, Island Peak, Denali, and, in 2022, the South Summit of Everest. He has written more than 30 books, and when not enjoying the sun and rocket launches, which he occasionally sees on his morning ten-mile runs, he divides his time with his wife Alice between their second home in Norway and Slovenia.



1

Commercial Astronauts

Why a book about commercial astronauts? To answer that question, it is necessary to peek into the democratization of space access. As you are no doubt aware, commercial space ventures are breaking down the traditional barriers that once confined space exploration to government agencies. The entry of private companies such as SpaceX, Blue Origin and Axiom Space into the space industry has democratized access to space, allowing a diverse range of individuals and entities to participate and an understanding of the dynamics of commercial astronauts is crucial in grasping how this shift is shaping the future of space travel. Second, commercial space companies are at the forefront of driving innovation and pushing the boundaries of technology, the planned expandable habitats of Sierra Space being an excellent example. The challenges faced by commercial entities such as Sierra Space often lead to the development of innovative solutions, impacting not only space exploration but also technology on Earth, and key to exploring these advancements are commercial astronauts. Third, the commercialization of space has significant economic implications. Beyond the inherent value of scientific exploration, space has become a frontier for economic activity, and only by understanding the role of commercial astronauts in this frontier is it possible to comprehend the economic opportunities, challenges, and potential for growth in this emerging sector. Fourth, as space becomes a more accessible domain, international collaboration and competition in space activities are intensifying, and at the center of these collaborations and competitions are...you guessed it: commercial astronauts! Fifth, the stories of commercial astronauts serve as a source of inspiration for aspiring space enthusiasts. Documenting their journeys, achievements, and challenges not only educates the public but also



Fig. 1.1 Blue Origin's New Shepard suborbital vehicle. (Credit: Creative Commons BY-SA 4.0)

fosters a sense of wonder and aspiration for future generations. The human stories behind these astronauts add a personal dimension to the grand narrative of space exploration, so let's begin there!.

So, your name is Jeff Bezos. Depending on what Elon Musk, the Mars Messiah, is up to, you may or may not be the richest person on planet Earth. Over the past several years, you have spent billions of dollars on a company called Blue Origin, developing a suborbital launch vehicle dubbed New Shepard. After several uncrewed flights, New Shepard (Fig. 1.1) is deemed ready for crewed flight and you, as the company owner, decide to take a flight. To make the flight even more significant, you graciously invite your brother Mark, Mercury 13 astronaut-in-waiting Wally Funk, and Dutch student Oliver Daemen. You and your fellow crewmembers launch on Blue Origin NS-16 on July 20th, 2021, on board RSS First Step. After the 10-minute 10-second flight, more than three of which were spent in microgravity, the crew returned to the launch site near Van Horn, Texas, and contemplated their newfound status as astronauts. Or were they? According to the Federal



Fig. 1.2 The FAA's commercial wings. (Credit: FAA)

Aviation Administration (FAA), the answer is no, but for Richard Branson, who had launched in SpaceShipTwo (SS2) the week before, the answer was yes. Perhaps. Confusing? A little. You see, shortly before NS-16 blasted above the Kármán Line (which SS2 did not, incidentally), the FAA decided to recalibrate their definition of what an astronaut may or may not be, but at the end of the day, to most people, it is just a question of semantics. NASA, ESA, the CSA and any other space agency you care to name, brand those who have completed astronaut training as astronauts, even though these employees have yet to fly. As far as the commercial definition of the term is concerned, we must turn the clock back to 2004, which is when the FAA announced its commercial wings (Fig. 1.2) program.

The FAA's commercial wings program aligned with the X-Prize that awarded \$10 million to the first private company to launch a crewed reusable spacecraft to 100 kilometers altitude (the international definition of space, according to the World Air Sports Federation, or *Fédération Aéronautique Internationale*, which decides these things) and repeat the feat within two weeks. As everyone with even a peripheral interest in spaceflight knows, the winner was SpaceShipOne (SS1), flown by Michael Melvill and Brian Binnie (Fig. 1.3), who were promptly awarded the first commercial astronaut wings by the FAA.

To qualify for commercial astronaut status back in those days, a person had to reach an altitude of 80 kilometers (not the 100 km stipulated by the FAI—the FAI and the FAA are two separate organizations), or 50 miles in (very) old money, and that person had to be a part of the flight crew, which the agency defined as:

any employee or independent contractor of a licensee, transferee, or permittee, or of a contractor or subcontractor of a licensee, transferee, or permittee, who performs activities in the course of that employment or contract directly relating to the launch, re-entry, or other operation of or in a launch vehicle or re-entry vehicle that carries human beings.



Fig. 1.3 (Left to Right) Marion Blakely (FAA). Mike Melvill, Sir Richard Branson, Burt Rutan, Brian Binnie & Paul Allen. (October 4, 2004). (Credit: D Ramey Logan)

Now you may be wondering what the status of the other passengers might have been, i.e.: those who were not part of the flight crew. Well, the FAA had a term for this group, badging them as spaceflight participants. Not the same ring as ‘astronaut,’ but better than the moniker ‘space tourist’ most agreed. After SS1 flew, bold pronouncements were made by one Sir Richard Branson about the hundreds of newly minted astronauts and/or spaceflight participants who would fly beginning as early as 2007, after having paid \$250,000 for their ticket (these tickets cost \$600,000 nowadays) to space. It was not to be. In fact, the commercial spaceflight world had to wait another *fifteen* years before another set of commercial astronaut wings were awarded, this time to Mark Stucky and Frederick Sturckow, who piloted SS2 in 2018 to an altitude of 82 kilometers—good enough to qualify as a spaceflight under FAA regulations, but not quite high enough if you used the FAI interpretation of space. SS2 flew again the following year when pilots Dave Mackay, Mike Masucci and passenger Beth Moses flew to an altitude of 89 kilometers. On this flight, the pilots received their wings, as did Beth Moses, who, as Virgin Galactic’s Chief Astronaut Instructor, evaluated the crew cabin, and therefore met the FAA’s definition of ‘flight crew.’ Stucky and Sturckow flew again in May 2021 (reaching 89 kilometers) and this flight was followed two months later by the flight that carried Sir Richard Branson to space—depending on how you

define space! So where did that leave Jeff Bezos? Well, the same day (20th July, 2021) that Bezos flew to space (exceeding the FAA *and* FAI definitions of space), the FAA modified their definition of what was required to be awarded astronaut wings, stating that such an individual must demonstrate activities during flight that are essential to public safety, or contribute to human spaceflight safety. This amendment was followed by a statement from the FAA explaining:

The F.A.A. has now changed its focus to recognize flight crew who demonstrate activities during flight that were essential to public safety, or contributed to human spaceflight safety, among other criteria. This change aligns more directly to the F.A.A.'s role to protect public safety during commercial space operations.

Based on these changes, Jeff Bezos and his fellow passengers failed to meet the criteria of being classified as flight crew because New Shepard is entirely automated, and all the passengers did was float around and take pictures. Did it matter? Not really, because shortly after landing, the foursome received custom (not FAA commercial astronaut wings) astronaut wings and branded themselves as astronauts. Virgin Galactic has adopted the same approach, creating its own astronaut wings for their wealthy customers who, at the time of their flights, paid \$450,000 for their ride to space. And for those of you who like pins, the Association of Space Explorers, an organization of past and present astronauts, has created two types of pins for those who venture into space. One pin, which is an up-and-down chevron, five-pointed star combination, is for those who complete a suborbital flight, and the other, for those who complete an orbital flight, has a circle added. Incidentally, the Association of Space Explorers does not use the terms 'astronaut' or 'spaceflight participants,' choosing instead to use 'space traveler.' Obviously, this book has decided the more apt term is commercial astronaut, so we're going to stick with that moniker from now on!

With all the talk about the flights of New Shepard, SS2, Axiom-1 and Polaris, it is easy to forget—in fact, the younger generation may not even be aware—that the first commercial astronauts flew more than 30 years ago. More than 20 years before the X-Prize and more than 30 years before the battling billionaires flew into space, there was a Japanese newspaper reporter, Tokohiro Akiyama, who, in December 1990, on behalf of the Tokyo Broadcasting System (TBS), spent 7 days on the Russian space station Mir. TBS sponsored the flight to celebrate its fortieth anniversary at a cost of around \$25 million (some sources put the number at \$37 million). To prepare, Akiyama began his preparation at the Yuri Gagarin Cosmonaut Training

Center in October 1989, more than a year before his flight. When Akiyama launched, it was, fittingly, inside a Soyuz plastered with TBS advertising. The era of commercial astronauts had truly begun. Akiyama's flight was successful, marred only by bouts of space motion sickness and cigarette cravings (Akiyama had a 40 a day habit). Akiyama was followed by chemist, Helen Sharman, who, much to the delight of the British media, worked for Mars confectionery. More than 30 years later, I can still remember some of the headlines (From Mars to the Stars, The Girl from Mars, etc., etc). Sharman, who was chosen from more than 13,000 applicants responding to a radio contest, spent eight days on board Mir as part of Project Juno, a political effort to improve relations between the UK and the Soviet Union. All for the price tag of \$10 million. Sharman (her spacesuit is on display in the Museum of Science in London), like Akiyama, spent more than a year at Star City training for her mission, which launched in 1991. Commercial astronaut activity died down a little after Sharman's ride, but in 2001, Space Adventures, a company specializing in space tourism, brokered a deal to fly American businessman, Dennis Tito, to the International Space Station (ISS). Tito had had a rocky ride getting his flight buttoned down. Initially he had arranged through MirCorp to fly to the ISS, but when he arrived at Johnson Space Center (JSC) together with two cosmonauts to begin training on the United States Orbital Segment (USOS), JSC Manager Robert Cabana, sent them packing, saying "We will not be able to begin training, because we are not willing to train with Dennis Tito." Undeterred, Tito (Fig. 1.4) approached Eric Anderson's Space



Fig. 1.4 The Soyuz TM-32 crewmembers. Right to left: Soyuz Commander Talgat Musabayev, Flight Engineer Yuri Baturin and Dennis Tito. (Credit: NASA/Public domain)

Adventures Ltd., and ultimately flew a seven-day mission in April 2001, for the bargain basement cost of \$20 million—less than one of the (suborbital) flights on Blue Origin's New Shepard more than 20 years later!

Next to fly was South African internet entrepreneur Mark Shuttleworth who, like Tito, launched to the ISS on board a Soyuz. During his eight-day mission, Shuttleworth, who paid around \$20 million for his flight, conducted various science experiments on HIV protein crystallization. Unlike Tito's flight, Shuttleworth's trip to the ISS generated less controversy, as he explained in an interview with NBC shortly after his return:

My sense was that there's now good momentum toward at least working with space flight participants that have come to the party along a different track," he said, "and that people within NASA are excited about the possibilities that that might open up for the agency and for the future of space exploration.

Mark Shuttleworth in an interview with Alan Boyle, NBC, May 13, 2002.

Source: msnbc.com

Because of the science he conducted during his stay, Shuttleworth argued against being branded a space tourist, saying he should be regarded as a fully-fledged astronaut. It's hard to argue against that given that Shuttleworth, like Tito and Sharman before him, had spent the best part of a year at Star City, training alongside the cosmonauts. After Shuttleworth there was talk of former NASA official Lori Garver blasting off to the ISS and then NSync (a somewhat famous boy band many years ago...so I'm told) singer Lance Bass. Bass began training at Star City for what was to be a ten-day trip to the ISS. After four months he was speaking passable Russian, had passed several pre-launch tests and everything was looking rosy. Even when his plan looked to be derailed by an irregular heartbeat, Bass, undeterred, underwent surgery to fix it. But one spanner in the works was money. Since Bass couldn't finance the trip independently, he reached out to Hollywood for promotional financing, and this caused more than a few problems. Because the money was not forthcoming, Bass found himself being kicked off the base some weekends, with the Russians demanding to know when the rest of the money was going to be paid. Eventually, negotiations disintegrated, and Bass's childhood (since watching a Shuttle launch at the age of nine, Bass had become infatuated with space and had set his sights on becoming an engineer. That plan was derailed seven years later when Justin Timberlake called Bass and offered him the job of bass singer) dreams of flying to space were stalled. But he hasn't given up as evidenced by his space-themed podcasts and his position as a member of the National Space Society.

After Shuttleworth's flight, attention turned to suborbital flight for a while, with media attention focused on the rebranded Ansari X-Prize. Created in 1996, when it was just called the X-Prize, this initiative was proposed by Peter Diamandis, an entrepreneur who was inspired by the Orteig Prize which, back in the 1920's, offered \$25,000 to the first aviator to fly across the Atlantic Ocean. The prize was eventually won by Charles Lindbergh in 1927, in his aircraft *The Spirit of St. Louis*. Diamandis reckoned a similar prize could be applied to the commercial spaceflight arena and offered the X-Prize, a \$10 million reward to the first private company to fly a spacecraft to the edge of space (above the FAI 100 km threshold and *not* the US military standard) and repeat the feat within two weeks. The prize, which was announced at the 1995 International Space Development Conference, spurred more than two dozen companies to develop all sorts of innovative...and in some cases, downright dangerous...ways to win the prize. One of the companies was Mojave Aerospace Ventures, which was led by legendary aircraft designer, Burt Rutan. Rutan's firm, Scaled Composites, was funded by billionaire Paul Allen to the tune of \$25 million, so they had a decided advantage over many other companies that were operating on a comparative shoestring. Rutan's X-Prize entry was dubbed *SpaceShipOne* (SS1), which was lofted to an altitude of 15,000 meters beneath a carrier mothership called *White Knight*, at which point the spacecraft was released and the spacecraft ignited its rocket engine that powered the vehicle to space. On June 21st, 2004, SS1 made history when, with Mike Melvill at the controls, it became the first privately developed spacecraft to reach space (100,124 meters), albeit for only 10.23 seconds. However, since the flight had not been registered as an X-Prize flight and because SS1 had not carried any passengers or equivalent ballast, the flight did not qualify as a competitive flight. But the SS1 fans didn't have to wait long. On 29th September 2004, with Melvill at the controls again, SS1, this time loaded with passenger-equivalent ballast, reached an altitude of 102 kilometers, and just a few days later, on 4th October, the feat was repeated when Brian Binnie piloted the spacecraft to an altitude of 112 kilometers spurring then NASA Administrator Sean O'Keefe to say the following kind words:

The spirit of determination and innovation demonstrated today shows that America is excited about a new century of exploration and discovery. We wish the *SpaceShipOne* team continued success and many more safe flights.

Sadly, the hopes for many more safe flights weren't to be, but we'll pick up that story in Chap. 8. After Binnie's and Melvill's suborbital jaunts, it was the turn of Greg Olsen, an angel investor who owns a ranch in Montana and a



Fig. 1.5 Greg Olsen attired in the Sokol suit. (Credit: NASA)

portfolio of Manhattan real estate. Just the sort of person who could fork out \$20 million on a spaceflight. He contacted Space Adventures and completed nearly three months of training when the flight surgeons noticed a black spot on one of Olsen's lungs and promptly grounded him. When he returned to the United States, the black spot had disappeared, so Olsen (Fig. 1.5) submitted his medical records for review and was tested again, but the response was a firm 'nyet.' This process was repeated eight times and eight times the group of 50 Russian doctors rejected Olsen's application. Finally, after *many* months of negotiating, the Russians shoved a pile of releases under Olsen's nose and the flight was back on trajectory.

Like Shuttleworth before him, Olsen, who launched to the ISS in October 2005, was not a fan of being labeled a space tourist, emphasizing in postflight interviews not only the significant amount of work and 18 months of training that he had to complete before being ready for the flight, but also the myriad experiments he conducted during the flight, ranging from remote sensing to astronomy. The spaceflight arena didn't have to wait long for the next commercial astronaut to fly. Less than a year in fact. On 18th September 2006,



Fig. 1.6 Depending on which categories you like to apply to those who pay for their flights to space, Ansari was either the first or second female spaceflight participant. (Credit: NASA)

less than a year after Olsen's flight, Iranian American Anousheh Ansari (whose family sponsored the X-Prize) became the second female commercial astronaut after Helen Sharman fifteen years previously. In common with previous commercial astronauts, Ansari (Fig. 1.6) conducted several experiments during her eight-day stay on board the orbiting outpost.

In an interview with ESA in February 2007, Ansari reflected on her decision to fly, saying.

Space and space exploration has been something that I have been doing since I was young. It started with a fascination – just watching the stars at night and wondering what is out there in the Universe and if there are other people living out there. It was a fascination with the mystery of space. That is something that has stayed with me through my childhood and my adulthood. Even though my career did not directly avoid becoming an astronaut, because I didn't want to, it became a motivation for me for success in business.

I don't like the term 'space tourism' or 'space tourist' because I feel that it doesn't do justice to what we do as 'spaceflight participants' or explorers. A 'tourist' is someone who decides to go somewhere, buys a ticket, takes their camera,

packs a bag and goes. For this experience, I had to train for six months in Star City, perform physical and mental training, learn all the systems of the space station and the Soyuz rocket. So, for me, I had to learn a lot more than a tourist would have to learn about their trip. The closest thing I can compare it to is people who go on exploration trips to Antarctica, or to the Arctic, or people who climb Mount Everest. You would never call them tourists. You would maybe call them 'expedition member' or some different terminology, but they would not like to be called tourists. So that is why I don't like to be called a 'tourist.'

ESA, February 2007.

Initially, Ansari trained as a backup to Daisuke Enomoto, a Japanese businessman who had hoped to become the next spaceflight participant, but in August 2006, he was medically disqualified due to a case of kidney stones and Ansari was re-assigned as prime crew. Undeterred, Enomoto did what any aggrieved spaceflight participant would have done in his circumstances: he filed a lawsuit against Space Adventures who had arranged the \$21 million flight. In the lawsuit, Space Adventures said it was aware of Enomoto's kidney stone problem and had advised the Japanese executive to treat them and that Enomoto had not, which resulted in the disqualification from the flight. Countering this claim by Space Adventures, Enomoto stated that the real reason he was bumped from the flight was that he had refused to pay more money for the flight. There was some discussion in the media that had Enomoto been successful in flying to the ISS he would have become the first self-funded spaceflight participant from Japan, after Akiyama's flight. Technically, this would have been true, but how many categories of spaceflight participant should there be? Space tourist, space pioneer, space explorer, spaceflight participant, self-funded executive, female space tourist, self-funded female executive, self-funded tourist, etc. For the purposes of this chapter and this book, we'll stick with the term commercial astronaut. During Ansari's flight (she became the second female commercial astronaut after Sharman), the businesswoman (she later became vice president of Sonus Network) conducted a variety of experiments including a study that investigated anemia, another that examined how muscle atrophy caused lower back pain and one that studied the effects of radiation. It is worth noting that a few years before her flight, Ansari became CEO of the Ansari X-Prize that funded SpaceShipTwo's winning flight to space in 2004.

Next on the list of commercial astronauts was Charles Simonyi (Fig. 1.7). You may not know the name, but it is almost guaranteed you have used a product that he built, namely Microsoft Office. An avid collector of Roy Lichtenstein paintings and good friend of Bill Gates, Simonyi signed an



Fig. 1.7 Michael Barratt, Charles Simonyi, and Gennady Padalka, and Expedition Commander at Baikonur before Simonyi's second flight in 2009. (Credit: NASA / Victor Zelentsov)

agreement with Space Adventures for a 10-day mission that launched in April 2007. He enjoyed the experience so much that he booked a second trip (you can do this sort of thing if you happen to be a billionaire), becoming—at the time—the only spaceflight participant to fly twice. His second flight, which took place almost two years after the first, launched in March 2009.

Not long after Simonyi's first flight, video game developer (Ultima game series anyone?) and entrepreneur, Richard Garriott, flew in October 2008 for a 12-day stay on board the orbiting outpost. For Garriott, his wait for spaceflight had been a long one as he had originally planned to fly in 2001, but in that year the dot-com bubble burst along with much of Garriott's bank account. So Garriott sold his seat to Tito, returned to game development and waited for his finances to be replenished. A few years later Garriott had resurrected his wealth and paid another deposit to Space Adventures. Unfortunately, during his medical examination, hemangioma was discovered on his liver, and he was disqualified from flight due to the risk of internal bleeding in the event of rapid depressurization (see Chap. 7). Unwilling to forfeit a second chance of flying to space, Garriott elected to have the angioma removed, was