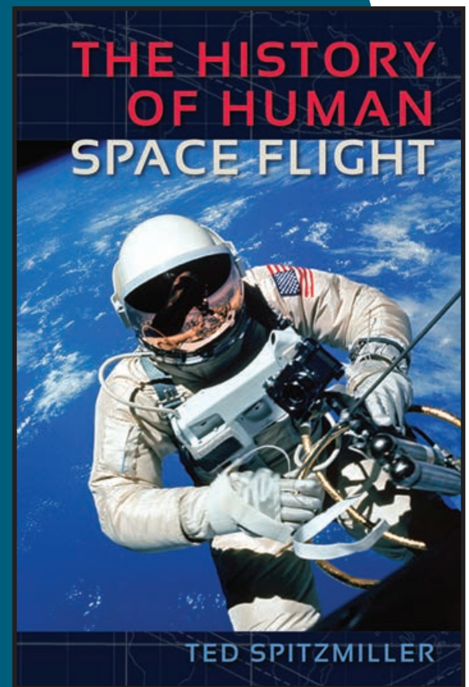
WHAT PEOPLE ARE SAYING



"Spitzmiller skillfully weaves stories from around the world and across centuries into a riveting narrative. An excellent blend of understandable technical explanations with a fascinating human saga of dedication, competition, sacrifice, and achievement."

—Dave Finley, National Radio Astronomy Observatory

"An ambitious and thorough history, extending back to the earliest risk takers and innovators who laid the groundwork for the astronauts and cosmonauts who would break the bonds of Earth."

—George Leopold, author of *Calculated Risk: The Supersonic Life and Times of Gus Grissom*

"A wonderfully synthetic and penetrating account of humankind's historic ventures into space and one of the most accessible books on space travel yet written."

—James R. Hansen, author of *First Man: The Life of Neil A. Armstrong*

"A well-researched space history full of little-known details that all space enthusiasts will want to add to their reference lists."

—Marianne J. Dyson, author of *A Passion for Space: Adventures of a Pioneering Female NASA Flight Controller*

THE HISTORY OF HUMAN SPACE FLIGHT

TED SPITZMILLER

978-0-8130-5427-8 • Hardcover $39.95
624 pages, 6 ⅛ x 9 ¼ , 198 b/w illus., 3 tables
UNIVERSITY PRESS OF FLORIDA • MARCH 2017

ABOUT THE AUTHOR

TED SPITZMILLER began his professional career in the military at the U.S. Army's Ordnance Guided Missile School in Huntsville, Alabama. He went on to nuclear weapons training at Sandia Base in New Mexico, where he taught for two years in the Atomic Weapons Training Group. He has worked for IBM, INTEL, and the Los Alamos National Laboratory from which he retired in 2001 to teach at the university level. Spitzmiller is a flight instructor (CFII) who has logged over 4,500 hours in more than 80 different types of aircraft. Combining his skills in writing with his knowledge of aerospace, he has previously published six books and a number of articles in major aviation magazines over the past 35 years.

Ted Spitzmiller

is available for interviews and appearances

For more information, contact the UPF Marketing Department:

(352) 392-1351 x 232 | marketing@upress.ufl.edu

Available for purchase from booksellers worldwide.

To order direct from the publisher, call the University Press of Florida: 1 (800) 226-3822.

Q&A

with

TED SPITZMILLER

author of

The History of Human Space Flight

What sparked your fascination with humans' relationship with space?

I have always been fascinated with aviation and space since birth. With the launch of Sputnik in 1957 my interest deepened, and I have enjoyed closely following the milestones that have marked mankind's advances.

Why did you consider the early balloonists and rocket plane pilots as a part of "space" history?

They faced the same unknowns as the modern-day astronaut and didn't allow the perils they confronted to deter them.

What about the future of space travel excites you most?

The prospect of humans venturing to Mars and settling it, at least as a scientific outpost, if not as a long-term enclave for humanity.

Why should the average person take interest in space travel?

Few realize how much of our daily commerce in communications, weather, and entertainment uses space as a medium (as well as military reconnaissance). The human presence allows us to explore the vantage point of a micro-gravity environment, without the hindrance of an atmosphere, to conduct a wide variety of scientific and commercial pursuits.

Why is it so important for organizations to continue pushing boundaries when it comes to space travel?

As with virtually every human endeavor, it is only by pushing the boundaries that we can understand more about our environment and ourselves.

What was your favorite piece of history to write about in your book?

That's a tough question, because I really enjoyed virtually every aspect. Perhaps the period from Sputnik I (1957) to the first human space flights of Gagarin and Shepard (1961), because I was an impressionable teenager during that period, and reflecting on those events brought back the excitement that I felt.

What is the day-to-day routine an astronaut undergoes to prepare for space?

When assigned to a specific mission, the astronaut works closely with the mission planners to understand the role they will play and the objectives sought. Of course, maintaining a special diet and exercise is important, as well as being exposed to some of the rigors of the launch environment, such as G-forces and weightlessness. Because there is a wide variety of specialists now involved in the ISS (our only current operational human program), training for the specifics tasks to be performed varies extensively.

If you had to choose a profession related to space travel, which job would you choose?

Of course, being the command pilot of a winged spacecraft, such as the space shuttle, would be ideal. But in today's automated and wingless spacecraft, there is little need for piloting skills. Rocket engine design would be an exciting second choice for the ground-bound engineer.

As someone who understands rocket science, what would you change the phrase "it's not rocket science" to say?

If people understood that so much of rocket science is not beyond their grasp, they might find their own endeavors to be just as exciting and challenging. Perhaps, "pretend it's rocket science."

What do you hope readers will enjoy the most about your book?

I can only hope that I have conveyed the excitement of the various periods and the extent of the personal effort and commitment that went into each event described, as well as the personal gratification of achievement that these pioneers savored.

1

AEROSTATS OPEN THE VISTA

Human space exploration began in a subtle manner, with the use of aerostats—balloons, as we more commonly call them today. These quiet, fragile creations, fully at the mercy of the winds, played an important role in the conquest of space. The balloon was an invention of an earlier time, and within the period of a few months in 1783, two forms of buoyancy were used to lift the first humans into space.

A New Invention: The Balloon

In 1766 Englishman Henry Cavendish discovered the properties of a gas that he called "phlogiston," which was one-fourteenth as light as air. When enclosed in a lightweight container, it satisfied the principles that Archimedes had defined regarding buoyancy; it floated. When it was recognized that this colorless, odorless, and nontoxic element produced water when it was burned, it received the Greek name hydrogen—for "water-former." Because of its most dangerous property, most people referred to it as "inflammable air."

In France, starting in June 1783, Joseph-Michel Montgolfier and his brother, Jacques-Étienne Montgolfier, experimented with the ability to fly small silk sacks filled with hydrogen. But, as the silk allowed the hydrogen to quickly escape because of its porous nature, they moved on to using "smoke." The particulates in the smoke tended to seal the envelope and retain the hot gas. These sacks, too, defied gravity—supported by the buoyant properties of rising hot air. Floating bags of hot air had been noted in both the Chinese and Indian cultures in past centuries. However, when the smoke cooled, it also descended.

The Montgolfier brothers filled inverted paper bags with a light cloth fabric with the smoke from a large hay fire. They did not actually understand the physics involved and believed that some properties of the smoke,

The Archimedes Principle

Archimedes (c. 287 BC–c. 212 BC), the Greek mathematician and philosopher, is credited with being the first to define the principles of buoyancy in his treatise *On Floating Bodies*. He writes: "An object immersed in a fluid is buoyed up by a force equal to the weight it displaces." Thus, a container (balloon) of a substance lighter than air (air being a fluid) will rise until its "weight" is equal to the volume of air it displaces.

not the hot air, provided the lifting action. Over a period of several months, they experimented with ever-larger bags (a product of their family's business). Their success generated not only notoriety but also an enthusiasm for ballooning that was caught by many—and the science of aerostats was born. It is from this word that the term "aeronaut" was also coined.

In an effort to validate scientifically the work of the Montgolfiers, the Academy of Sciences in Paris authorized French inventor, scientist, and mathematician Jacques Alexandre Cesar Charles to duplicate their work. However, Charles believed they had continued to use hydrogen and thus the validation effort actually expanded on this original path to lighter-than-air flight—and a friendly rivalry.

Adding to the rapid advance in the art of ballooning was the invention of a rubber coating for silk (by the brothers Jean and Noël Robert), that allowed Charles' envelope to retain the hydrogen. The "inflammable air" was generated by pouring sulfuric acid over iron filings. This produced hydrogen gas, which filled the envelope of his balloon that he aptly named the Globe. America's Ben Franklin (then U.S. ambassador to France) was one of those notables who watched the ascent of these as-yet unmanned aerostats with great interest.

In Versailles, the Montgolfiers' next spectacular balloon was *Aérostat Réveillon*, named for Jean-Baptiste Réveillon—the manufacturer who produced the beautifully adorned paper from which Jacques-Étienne fashioned the envelopes. This colorful 40 ft. tall balloon was sent aloft in September 1783. The passengers aboard this pioneering flight were a duck, a sheep, and a rooster. Each animal had a scientific purpose, with the sheep representing a close approximation of the human physiology. There was concern about possible negative effects of a flight into the "upper atmosphere"—thus the caution.

Competition developed between the brothers and Jacques Charles to send aloft a human. Several tethered tests were made with Jacques-Étienne on board to gain experience and confidence in the balloon. Techniques for feeding the central fire basket to supply the smoke (hot air) were also developed.

King Louis XVI had become an ardent supporter of these experiments and suggested that two prisoners be the first aeronauts because of the risk. However, the brothers prevailed, citing the high probability of success and the fame the first fliers would acquire. Thus, Jean-François Pilâtre de Rozier, a French chemistry and physics teacher, and François Laurent le Vieux d'Arlandes made the first human free balloon flight in November 1783 in a Montgolfier balloon.

Launched near Paris in the presence of the king and Marie Antoinette, their twenty-five-minute flight traveled more than 5 mi. while attaining an altitude of about 3,000 ft. The 75 ft. tall balloon had a volume of 56,000 cu. ft., which compares with a typical modern-day four-passenger hot air balloon.

While the event is not celebrated to the extent of the first powered heavier-than-air flight by the Wright brothers, Orville and Wilber Wright, in 1903, it was the first major milestone for humans to break away from the gravity well that constrains us to the planet. With the ability to seal the envelope, hydrogen became the buoyant gas of choice. The use of "hot air" faded for two hundred years until the use of propane burners brought a resurgence to the sport of hot air ballooning in the 1970s.

From this point forward, the space above Earth could now be explored and its attributes measured. However, most of the flights for the next hundred years were made to set records and exploit the moneymaking potential of balloon exhibition flights rather than to advance science.

A month following the first human ascension, in December 1783, Jacques Charles and Nicolas-Louis Robert launched their balloon in Paris. The 13,000 cu. ft. hydrogen-filled balloon used sand ballast to control altitude. They ascended to a height of about 1,800 ft. and landed after a two-hour flight covering 16 mi. Sand was the ballast of choice, being easily dropped without hurting anyone below, as the new aeronauts learned their craft by trial and error.

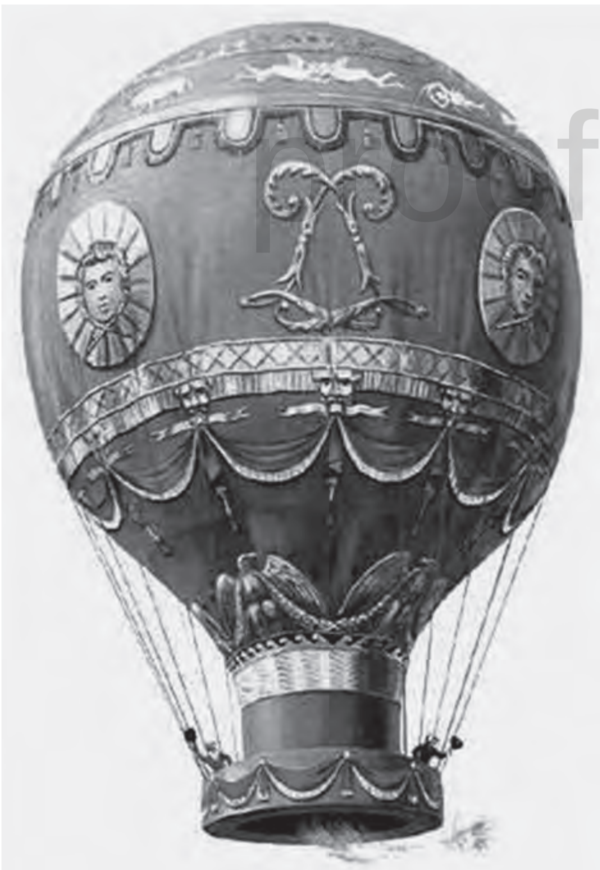
De Rozier died when another balloon he was piloting crashed during an attempt to fly across the English Channel. He and his companion, Pierre Romain, became the first known fatalities in the conquest of space.

The first balloon flight in America took place a decade later, in January

Ballast and Buoyancy

Gas balloons use ballast to control buoyancy during flight. Sand or water is carried aloft at launch and released in controlled measures by the pilot to adjust the balloon's altitude by reducing the gross weight of the balloon, which will then rise to a new pressure altitude.

To descend, lifting gas is released by a valve atop the envelope. The balloon will remain at its equilibrium altitude until there is another dynamic change in the lift equation. The descent to the ground is a critical operation as the trade-off between the valving of lifting gas and the descent rate is controlled by releasing the remaining ballast. Hot air balloons simply allow the envelope to cool to descend, and heat the air to stop the decent or to re-ascend.



Jean-François Pilâtre de Rozier and François Laurent le Vieux d'Arlandes made the first free balloon flight using hot air as a lifting medium in November 1783. Courtesy of Bibliothèque Nationale, Paris.

1793, when the noted French balloonist Jean-Pierre Blanchard ascended from Philadelphia, Pennsylvania, and landed in Deptford Township in New Jersey. Witnessing the ascent that day were President George Washington and future presidents John Adams, Thomas Jefferson, James Madison, and James Monroe.

Ascending to New Heights

Although the emphasis of these early flights was to entertain by setting records rather than to advance true science, the almost tragic by-product of many stunts revealed the lack of knowledge of this new high-altitude environment. By 1804 several balloonists had topped 20,000 ft. The 1862 ascent of Henry Coxwell and James Glaisher of England claimed 29,000 ft., and the pair narrowly avoided death from hypoxia and freezing.

The year 1875 saw the deaths of Théodore Sivel and Joseph Croce-Spinelli in their record attempt to 28,000 ft. A third member of the crew of the balloon named *Zenith*, Gaston Tissandier, barely survived. There was a lot to learn about traveling in this region high above Earth.

Arthur Berson, a Polish meteorologist and pioneer of aerology, and Reinhard Süring, a German meteorologist, set a record of 35,424 ft. in 1901 (although the actual height was doubted by many authorities of the time). This represents the altitude at which current jetliners routinely operate and is about one-tenth the distance to the Kármán line. The world had to wait more than twenty-five years before that record would be surpassed.

In 1896 French meteorologist Léon P. Tisserenc de Bort undertook a significant investigation of the upper atmosphere by sending several unmanned balloons to 50,000 ft. In the days before electronic telemetry, Tisserenc de Bort's effort relied on mechanical recording devices, which revealed significant changes in the character of the regions of the atmosphere through which the balloon passed. He termed the areas closest to Earth (within 6–8 mi.) the troposphere and the area above 40,000 ft. the stratosphere, where he perceived there was virtually no weather phenomena.

By the late 1920s supercharged engines allowed airplanes to achieve brief flights of up to 30,000 ft., and heavy clothing and oxygen were now recognized as minimal equipment. Lacking pressure-breathing apparatus, U.S. Army captain Hawthorne C. Gray passed out at 27,000 ft. during his 1927 flight, and the balloon descended on its own—with the pilot regaining consciousness in time to avoid a catastrophic landing. The sand ballast alone weighed two tons.

Oxygen Systems

As aircraft achieved higher altitudes, these early pilots recognized that they were not getting enough oxygen into their blood, and they were suffering from hypoxia. Although oxygen levels at all altitudes are constant (about 20 percent of the gases in the atmosphere, with nitrogen making up about 78 percent), simply providing higher percentages of oxygen when flying above 12,000 ft. was not enough. As the altitudes went beyond 25,000 ft., the lack of atmospheric pressure, mandatory for the oxygen to enter the hemoglobin of the blood, required "pressure breathing." With discoveries such as this, science was now beginning to play a more significant role in enabling these higher flights.

In his second attempt two months later he reached 42,240 ft. but ran out of ballast and had to parachute from the rapidly descending gondola at 8,000 ft. Because he did not land with his aircraft, as Fédération aéronautique internationale (FAI) rules required, his record was not recognized. A similar situation confronted the first Soviet cosmonaut thirty-five years later.

By this time the goal of simply establishing a new record, as appealing as that may have been to the participants (and for national pride), could no longer be the sole justification for flights. Science had to be the fundamental rationale, especially when government sponsorship was involved—the U.S. Army, in Gray's situation. Mechanically driven instruments had to be perfected that would—just like the crew—function reliably in the low pressures and temperatures experienced.

On his third and fatal flight, despite extensive preparation, Gray scribbled a final hypoxic note at 40,000 ft. that described the deep blue sky and brilliant sun. He also indicated that he had depleted his ballast. With his radio antenna broken (while discarding an empty oxygen tank), there was no communication, and his fate was not known until the following day when his lifeless body was found in the remains of the gondola. The cause of death was apparently not from the hard landing but more likely due to hypoxia or heart failure. The recording instruments indicated 44,000 ft. Capt. H. C. Gray, the first human ever to exceed 40,000 ft., is interred in Arlington National Cemetery.

Despite the advanced planning and courage of men like Gray, the technology of the time had not kept pace. Effective life-support systems as well as more advanced envelopes and ballast were needed, along with more accurate and reliable scientific instruments.

Auguste Piccard: 1931 Flight

Swiss physics professor Auguste Piccard profoundly changed the character of exploration of the upper atmosphere—the fringe of space. In retrospect of his accomplishments, he wrote: "The sport of the scientist consist of utilizing all that he knows of foreseeing the dangers, of studying every detail with profound attention, in always using the admirable instrument of mathematical analysis where ever it could shed its magic light upon his work" (quoted in Ryan 1995, 40).

Piccard was an early ballooning enthusiast who, with his twin brother, Jean, had flown from Zurich into France in 1913. Both had served in the Swiss Army lighter-than-air service in 1915. He recognized the need to provide a safer life-support system for high-altitude flight and in 1931 had fashioned a hermetically sealed (airtight) crew capsule—the precursor of the true spacecraft. The spherical, 7 ft. diameter cabin had eight small double-pane glass portholes and could accommodate two observers and a few hundred pounds of scientific instrumentation.

Piccard's first record flight attempt took place in May 1931, from Augsburg, Germany, using a 500,000 cu. ft. hydrogen balloon. Ascending rapidly,

Pressurized Environments

By sealing the capsule, the occupants were maintained at the ambient pressure of the launch environment—sea-level pressure being 14.7 psi (760 mm) and the standard percentage of oxygen would suffice. This also allowed greater warmth as higher-pressure air can more effectively maintain heat. A small Dewar of liquid oxygen provided for the replacement of that vital life-sustaining gas. It was periodically poured out on the floor of the gondola and, due to its extremely low temperature (-297 degrees), it immediately evaporated into the cabin's atmosphere. To "scrub" the encapsulated air of the exhaled carbon dioxide, Piccard adapted a recent discovery of chemically removing the gas.