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Chapter 6

The Dr. Wernher von Braun Vision*

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Abstract

One hundred years ago, the birth of visionary Dr. Wernher von Braun significantly changed the course of rocket science and space exploration. His influence on space exploration has led to enhanced observation satellites, robotic exploration vehicles, advanced rockets capable of carrying humans to space, man walking on the Moon, and the initial concepts for the Space Shuttle. Dr. von Braun loved all aspects of space exploration and had visualized a strategy for the future of human spaceflight. He proposed establishing a permanent human presence in space through circular space stations and lunar science laboratories with the intent of human exploration of Mars. In honor of his 100th birthday, this chapter compares Dr. von Braun's plans for future space missions with both the reality of events that have unfolded since the Apollo age and key issues he and NASA would have encountered if the space program had progressed as he suggested. These issues include astronaut health, such as radiation exposure and the loss of bone density in a microgravity environment; technology needed to achieve the dream, such as artificial gravity and the replenishing of material on long duration spaceflights; and political limitations that would have influenced major decisions.

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Introduction

Outer space, what is out there and how can we find out? Since childhood Dr. Wernher von Braun was fascinated by this question. His passion and curiosity led to many scientific discoveries in space science during the mid-1900s. As part of the U.S. space and rocket team, Dr. von Braun helped to advance the human space exploration program. That universal program has, so far, sent humans into orbit and to the Moon. He understood that it is the human desire to explore the unknown that propels people to achieve impossible things. The life and personality of Dr. von Braun is intriguing because of the many experiences he had. An inspired child, a war time engineer, and a space exploration hero make Dr. von Braun a very controversial person today. The purpose for writing this chapter is a personal research project for the author and to gain professional writing and presentation experience through the International Astronautical Congress. It is also to recognize a man who had a significant influence in the progress of space technology and who impacted the many people who worked to make the space program a success.

Figure 6–1: Wernher von Braun, 1955 filmed lecture to the Armed Forces Staff College. Credit: National Air and Space Museum, Smithsonian Institution.

Impossible

During research, there was one word that appeared in almost every text: impossible. After taking a closer look at the context in which this word appeared,

it was noticed that each author used the concept of impossibility differently. Some used it to describe space travel as being impractical, but a few used it as motivation. The latter believed "impossible" was something to be pursued and used to advance science and technology. This was the attitude of Dr. Wernher von Braun. He and his team accomplished "impossible" things every year. In 1912 no one thought that in the next hundred years man would build powerful rockets, put satellites in space, send men to orbit, later to the Moon, build a space station, or see the surface of Mars through pictures sent from robot rovers discovering Earth's nearest neighbor. "The past few decades should have taught us to use the word 'impossible' with the utmost caution"[3]. Von Braun frequently said this to motivate his team of space explorers and reevaluate the meaning of impossible. He believed anything was attainable with the right technology and attitude.

Background

The German Days

Although the years Dr. Wernher von Braun spent in Germany are not directly related to the conclusion of this chapter, it is necessary to understand his personality and his passion for space travel. Von Braun was born in Poland in March 1912. From childhood he displayed an interest for the stars. When he was eight years old his family moved to Berlin, Germany. At the age of 13, von Braun's attraction to astronomy was sparked when he received a telescope from his mother, who herself was an amateur astronomer. His mother also gave him a book by Jules Verne full of stories of space travel. This pushed his imagination and started his lifelong journey of space exploration.

After being held back in school for bad marks in mathematics, von Braun's parents sent him to boarding school, about three hours from Berlin. While studying there he came across a book written by Hermann Oberth called *Die Rakete zu den Planetenräumen* (*The Rocket into Interplanetary Space*). He studied the book and developed a hobby for rocketry. However, before he could pursue this new hobby he had to learn the mathematics behind it. By the time von Braun was 19 years old he had become known for his dreams of space and his skills with rockets. He joined Verein für Raumschiffahrt or VfR (Society for Space Travel) where young von Braun was able to experiment and learn about space rockets.

Unfortunately, Germany's political agenda would have von Braun to take a path less appealing.

Figure 6–2: Operation Paperclip, 1946. Credit: U.S. Space and Rocket Center.

He soon joined the socialist and Nazi parties to continue his study of rockets. In 1934, von Braun received a Ph.D. from the Technical University of Berlin. Being a member of the military he was placed in the rocket and missile division. It was in Peenemünde, Germany, that he and a team of engineers designed the V-2 rocket, which was the first long-range rocket to be used in war. As World War II came to an end, von Braun and his team of rocket scientists and engineers surrendered to Allied forces and were brought to Fort Bliss, Texas. Von Braun later called it a moral decision to surrender to the United States. They began working for the U.S. Army at Fort Bliss, Texas. They were known to the military as program Project Paperclip.

Rocket City, U.S.A.

After the events of World War II, the Unites States realized it needed an advanced rocketry division. In 1950 von Braun and his team were moved to the Redstone Arsenal in Huntsville, Alabama. They were assigned to the Redstone Arsenal. They joined a number of rocket scientists on projects such as Hermes, the Redstone rocket, and Jupiter rockets. Huntsville, Alabama, would soon become an important piece of the U.S. space program. The first Redstone rocket was launched from Cape Canaveral on 20 August 1953. Four months following the launch of Sputnik, the Redstone rocket successfully launched the first U.S. satellite, Explorer 1, on 1 February 1958, from Cape Canaveral, Florida. On 1 October 1958, the National Aeronautics and Space Administration (NASA) was created by President Dwight D. Eisenhower. Two years later, Marshall Space Flight Center (MSFC) was established, transferring von Braun and his team from the Army to NASA. They brought with them the Jupiter, Juno, and Saturn projects.

Figure 6–3: John F. Kennedy Moon speech to Congress, 25 May 1961. Credit: NASA History Office.

These clustered engine rockets became the primary goal of MSFC. With Dr. Wernher von Braun as MSFC's new director, the "Space Race" between the United States and the Soviet Union intensified and accelerated. This kind of event is just what von Braun needed to further his research in space travel. It was the opportunity to achieve something deemed impossible at the time. In 1961 President John F. Kennedy gave the United States a directive, which would become MSFC's goal for the next decade. "First, I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and retuning him safely to Earth." This is the promise President Kennedy gave the United States in a speech to Congress about urgent national needs. Von Braun and his team were more than enthusiastic about this project. For the first time they would design a rocket whose purpose did not include weaponry. Keeping with the enthusiasm, von Braun initiated a new section of MSFC called the Futures Projects Office. These engineers, scientists and artists were tasked with designing projects that would sustain America's future in space travel. Projects examples included Nova rockets, space stations, space shuttle, Moon and Mars bases, satellites, and various science experiments. This office lasted only a few years, but a committee was formed in Congress to examine their work further. By the end of the decade NASA kept its promise and on 20 July 1969, Americans landed on the Moon, traveling on top of the famed Saturn V rocket. Accomplishing this goal put MSFC in Huntsville, Alabama, on the map. In doing so, MSFC was given different tasks in reaching new heights in space exploration.

The Twenty-Five Year Plan

In many documents and interviews with Dr. Wernher von Braun, people tell stories of a passionate and animated man. While discussing science he was like a school boy [1], excited to discover something new. In a special newspaper article written for the *Huntsville Times*, Ed Buckbee, a colleague of von Braun, stated that "von Braun was a true crusader for manned space flight and always looked to the future"[7].

While this part of his personality charmed the world he had a hard determination. Von Braun loved designing rockets, but he was not a fan of designing weapons. His dedication to exploring space aided in his determination to achieve his dreams. As an enthusiastic space advocate von Braun constantly thought about the future and what could be the next step in space exploration. During his time in Peenemünde, Germany, he and his fellow officers would discuss many strategies for space travel. Von Braun wrote down these ideas and formulated a timeline for which man would explore space. Beginning in 1952, he began publishing a series of articles in *Collier's Magazine* engaging the public in the new Space Age. Since the initiation of the Apollo program he determined a timeline for mankind's next 25 years in space. These plans were each a stage to move onto the next project. The Shuttle would fly to low Earth orbit assembling a space station. The crew of the space station would build a larger space ship that would take humans to the Moon and Mars. In the late 1940s he wrote a manuscript explaining some of the details of a Mars mission, published as Das Marsprojekt in 1952, which was later published in English in 1953 as *The Mars Project*. Finally, the plan included designs for Moon and Martian bases.

Promoting Space

Von Braun understood all aspects of achieving space travel. He knew there had to be good management, dedication, and communication. In order for a program to achieve anything the person in charge has to be involved in every step. They need to inspire their team and understand the needs of each department. While examining the actions von Braun took to ensure his team was motivated, several items stand out. First, he read mandatory weekly notes that were submitted to him describing the progress that was made the previous week. He read each and every one of them, often leaving notes of encouragement or concern for that project. If there was a problem that was taking a while to solve, he would offer his help and time.

He would also leave a special note for teams who were falling behind "Remember, you're on the critical path"[7]. Based on experience, the best thing a leader could do is to make each person feel important to the goal. Second, von Braun gave each person his undivided attention when speaking. He took the time to understand fully what the person was trying to convey. If he didn't understand something, even though many thought he should have, he was not afraid to ask the question. This should be a trait every engineer and scientist aspires to possess. Working for von Braun had to be an adventure each day with encouragement and attention being common in the work place. Dedication to a project was also needed. If a leader doesn't fully engage in their project, how do they expect their team to believe in it? Von Braun promoted space in his everyday life. When he committed himself to something, he followed through with it. Space exploration had always been a part of him and that showed to his peers.

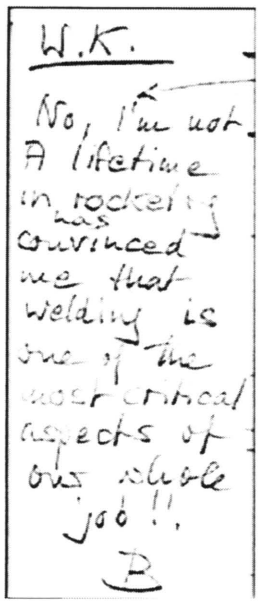

Figure 6–4: Example of a comment von Braun left on weekly notes. Credit: Ed Buckbee, WVB Special for the *Huntsville Times*, 2012.

After arriving in the United States, von Braun learned about its government. He learned that if he wanted support for space exploration projects he had to get the public's interest. From that point he wrote many newspaper and magazine articles, participated in interviews, and created television shows to convey his ideas to the people. This was a concept not well accepted in the scientific community. One does have to his admire his ability to communicate his thoughts and ideas. Especially when reading his published works in *Collier's Magazine* where he wrote a series of articles describing his plan of manned space exploration. This magazine reached thousands of people, gaining their interest. The public wondered, "Who is this rocket man and does he really think space travel is a possibility?"

They embraced von Braun's ideas because he used language everyone would understand. He made it easy to scientifically follow programs without having to be a scientist. This way of communicating exists very much today. Most news conferences are held so the general public knows what's going on. The ability to fully communicate ideas is a skill most scientists and engineers have to develop while in school. Students also know how to use the media for research, fun, and information. In the late 1950s televisions had become popular. Most

households had one in their living room where friends and family would gather to watch programs. With all of the press conferences and news articles, von Braun gained the attention of Walt Disney. Disney invited von Braun to participate in a new show that showcased the latest science ideas. Von Braun accepted and made a miniseries called "Man in Space." This got a lot of attention because people were able to watch and listen as he explained ideas of how to travel to distant places in space. There are many more examples of how von Braun was able to communicate effectively to the public the real possibility of frequent space travel.

Figure 6–5: Dr. Wernher von Braun (right), Walt Disney (left), 1954. Credit: NACA.

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A Reusable Shuttle Craft

Most people recognize the Space Shuttle that launched and supported many science experiments, satellites and built the International Space Station over the past 30 years. However, they do not know about the previous designs and ideas for a space shuttle. As part of the 25 year plan von Braun designed a reusable spacecraft, called the space shuttle. Although he was not the first to think of this, he contributed greatly to space shuttle science.

The comparisons show that von Braun's space shuttle and NASA's Space Shuttle are quite different. However, the missions for each shuttle were very similar. Both shuttles were intended to be the backbone of a larger project, a flying laboratory or space station. Von Braun's shuttle was a four-stage rocket using 29 engines in just the first stage. It would lift off in a vertical path heading for space. Astronauts were strapped inside the orbiter positioned on top of the rocket.

The orbiter was a winged vehicle capable of carrying ten to twelve passengers plus 36 tons of cargo. When the rocket attained 24.9 miles (40 km), reaching 5,256 miles per hour (8,459 km/hr), the first stage would depart, automatically firing the second stage [6].

The second stage would continue until the rocket reached 39.8 miles (64 km) above the Earth, accelerating the shuttle to 14,364 miles per hour (23,117 km/hr). At this point the second stage would then detach from the rocket and disintegrate as it falls back toward Earth. The third stage now fires giving the shuttle the final push to reach an orbit of 1,075 miles (1,730 km). While traveling 15,840 miles per hour (25,494 km/hr) above the Earth scientists and engineers assemble space stations and rocket ships that would explore the Moon, Mars and beyond. Once a specific mission is completed the astronauts return to the orbiter and prepare to head home [6].

The third stage would now detach, staying in orbit. The orbiter rotates facing the nose opposite of the direction it's traveling. The fourth stage fires, slowing the craft, allowing it to enter Earth's atmosphere. The orbiter was designed as a complicated glider with minimal flight control. It has a protective heat shield that is easily replaceable and it is equipped with landing gear which allows the orbiter and the astronauts to safely land the craft like an airplane [6].

While reading about the different stages of von Braun's version of a space shuttle, it sounds similar to NASA's Space Shuttle which was a completely successful program. The Space Shuttle's official name is Space Transportation System (STS). It too is a multistage rocket with a glider aircraft that has been man-

rated and returns back to Earth like an airplane. The shuttles are also similar in their restrictions. Neither shuttle is capable of leaving Earth orbit and both are expensive to build and launch. However, if the cost of von Braun's space shuttle and the STS were compared, STS would cost substantially less.

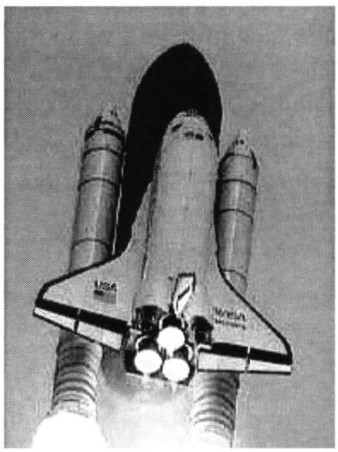

Figure 6–6: Space Shuttle *Discovery*. Credit: NASA Station and Shuttle, Shuttle Image Gallery.

This is because the STS used three main engines unlike von Braun's shuttle, which used 29. The STS used a combination of solid- and liquid-propellant motors. The main engines used liquid oxygen and liquid hydrogen as its main fuel source verses the more expensive liquid propellants of von Braun's shuttle. The STS is a four-part space vehicle that consists of two solid rocket motors, an external fuel tank, and an orbiter that uses three RS-25 engines. The solid rocket boosters (SRB) contain ammonium perchlorate, aluminum, iron oxide, a polymer (either P BAN or HTPB), and an epoxy curing agent. The SRBs account for approximately 86 percent liftoff power. After they burn out, they detach from the external fuel tank, fall into the ocean, recovered by NASA and are reused on future flights. The external fuel tank carries 1,621,722 pounds (735,601 kg) of liquid oxygen and hydrogen. Its main function is to refuel the Orbiter after liftoff. Carrying six to eight people, the STS Orbiter is the most similar part to von Braun's shuttle. It is a winged vehicle that houses astronauts, experiments, and is used to create other space exploring objects. It glides back to Earth having minimal steering control and lands on a runway like an airplane and is reused on future flights. Having three fourths of the STS be reusable made it the logical choice for funding.

Although Dr. von Braun did not get the chance to watch a STS launch, he would have been proud of the achievements it made during its 30-year mission.

These achievements include many scientific discoveries about the human body and a microgravity environment, deployment and repair of the Hubble Space Telescope, deployment of the Chandra Telescope, collection of many experiment satellites, Spacelab experiments, and circulating crew to space station Mir and the International Space Station. The biggest accomplishment of the STS is the building of the International Space Station, which serves as a microgravity science laboratory for 16 different countries.

The Space Station

Humans establishing a permanent presence in space had always been as science fiction or something that could only exist in the distant future. Von Braun was correct in 1952 when he said it was possible to have a space station built and operational by 1974. In 1973, the Skylab space station was completed and launched into a 274 mile (441 km) orbit by an unmanned Saturn V rocket. It was a small space station that performed numerous microgravity experiments. When Skylab fell, the United States designed a new space station, and with the help of its international partners, humans once again had a permanent presence in space aboard the International Space Station (ISS). It still orbits today at 27,743 km/hr (17,239 miles per hour) at 402 km (250 miles) above the Earth. Sixteen different countries utilize the ISS and work together to keep it going. Von Braun knew that team work was essential to a successful space program, however it is unclear whether he ever suggested collaborating with other countries to achieve a goal. Judging on how easily he adjusted to American life, and working with many different kinds of people, surely it crossed his mind.

During his time though, national pride was very important. Each country wanted to achieve goals themselves in order to have world superiority. By the end of the 1980s many accomplishments in space travel had been made and relations with the world's leaders in space were revamping. Thus, an international space project was a logical next step.

The stations just discussed were great pieces of engineering and science, but neither was as elaborate as the station von Braun visualized. In *The Mars Project* von Braun describes in detail a space station that would serve many purposes. As illustrated, the station would be circular with three decks, two docking sections, and a microgravity laboratory in the middle. In order to simulate gravity, the station would spin three times a minute using the force of inertia to "ground" the astronauts. It would be assembled in space using the space shuttle. The station would be made in collapsible parts making it easy to assemble using minimal space shuttle flights. Like the ISS, the station was to be used as a platform for larger projects, such as Moon and Mars missions.

The original plan was to have the station in a 1,730 km (1,075 mile), two-hour orbit around the Earth. After the launch of Explorer 1 and Explorer 3, the Van Allen Radiation Belt was discovered putting the station right in the middle of deadly radiation.

If the station could be built, and its position changed, astronauts would assemble larger space ships. These ships would take humans to the Moon and Mars and create bases where scientists could spend months researching the celestial bodies. Von Braun's plan was to build ten space vessels, seven astronauts on each, and fly to Mars. After leaving Earth's orbit they would enter an elliptical orbit around the Sun in a tangent line to Mars and coast after the appropriate speeds were attained. After achieving orbit around the red plant, three landing boats would depart and land on the surface. Experiments and studies would be performed collecting valuable data. Two of the landing boats would return to the fleet where they would depart from their historic landing heading home. This segment of the plan obviously never happened. Although it has the potential to succeed and is thoroughly thought out, it unfortunately never had funds to support it. Still, mankind ultimately left its marks on another celestial body closer to home, the Moon.

"One Small Step for [a] Man"

"One giant leap for mankind." These were the words of astronaut Neil Armstrong as he became the first person to walk on the Moon. These words perfectly described the moment when the sky was no longer the limit. On top of the Saturn V rocket, mankind blasted into a new era. Von Braun and his teams at MSFC built the Saturn V rockets part of the Apollo program.

As mentioned before, the United States was in a Space Race with the Soviet Union, that was challenging a competitor. Up until the Moon landing, the Soviet Union had been the first in almost everything space related. Which is interesting because up until Sputnik was launched not many people knew that the Soviet Union had an advanced space program. The United States wanted that same privilege. In 1961, President Kennedy gave them the resources needed to successfully complete a Moon mission. Eight years later, Neil Armstrong, Buzz Aldrin, Michael Collins completed that mission. Of course, von Braun had other plans for the lunar surface. As illustrated in the picture presented in *Collier's Magazine* he wanted Moon bases with regular trips to the Moon. He saw that the United States could have lunar bases in the 1980s. It was an ambitious target as was the Mars mission, but they further demonstrated von Braun's passion for space travel. Again, Moon bases were out of the budget; however advanced satellites are now used to explore the Moon, Mars, and the solar system.

The Unexpected

Although von Braun was a brilliant person, there were many key issues with space travel not known or well understood that hindered his vision. Von Braun believed the issues of cosmic rays were simple enough to solve quickly.

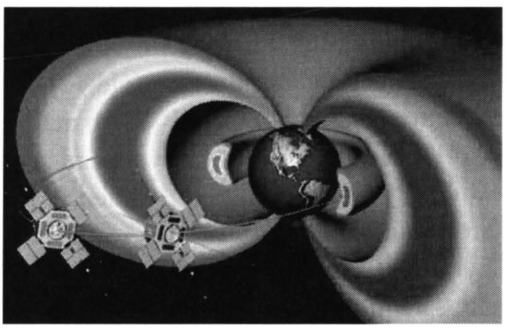

Figure 6–7: The radiation belt storm probes, 30 August 2012.
Credit: science.nasa.gov.

However, the Van Allen radiation belt and cosmic radiation are still obstacles today. If a person were to travel to Mars tomorrow, they would almost certainly die of radiation poisoning before returning home. Tiny asteroids are also a problem in space. As observed on a solar panel of the ISS, even the tiniest bit of material flying through space can be detrimental to a spacecraft. Technology is being invented today to protect space vessels, but no practical metal has been found to withstand the impact of space debris.

New and efficient systems of propulsion are available today. Von Braun had been interested in and researched with nuclear powered rockets, but at the time anything nuclear was considered with extreme caution.

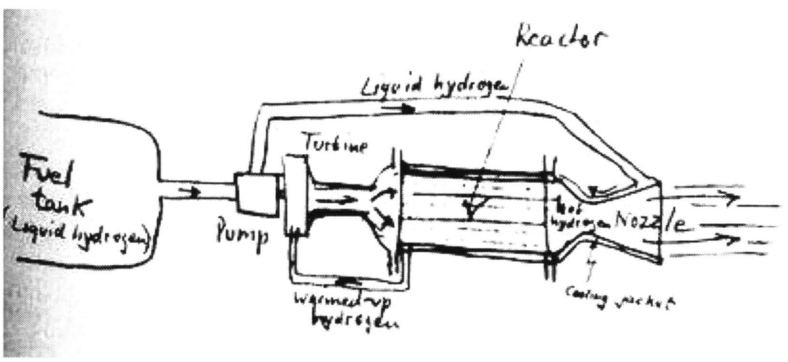

Figure 6–8: A sketch by von Braun describing a nuclear engine reactor.
Credit: Dr. von Braun, in *The Mars Project*.

Advances in electrical and ion propulsion will make spaceships already in orbit more efficient and effective in long-range space travel. As von Braun knew, progress is a result of the technology available. As technology advances, more opportunities for exploration become available.

Von Braun believed man should be exploring the solar system. In his dedication speech for the U.S. Space and Rocket Center he said "I truly believe that the progress of mankind on Earth is directly linked to the future that man builds for himself. That is the story which must be told"[2]. He did not trust robots could explore space better than man. For this reason automated explorers are not found a lot in his works. However, robots, rovers and satellites are significantly cheaper to send exploring the solar system. Although man has not made it to Mars yet, von Braun would be impressed by the rovers sent and the data and pictures sent back to Earth for observation. He would also be fascinated by data collected from the many satellites in orbit and in the solar system. When von Braun retired, he was asked about how his work would continue. Frederick I. Ordway III recalled von Braun's statement in an interview about the National Space Institute, "As you get older and approach retirement age, somebody else picks up where you left off." Von Braun continued, "There were great men long before the first big rockets were built. And we are just building on their legacy. We want to make sure that this legacy can now be passed on to the next generation, the people who will really pick the fruits of the trees we have planted." He was right. The next generation of engineers has continued the work of the space age rocket men.

Conclusion

Dr. von Braun's vision for space travel is still a fascinating engineering and scientific idea. His ultimate goal of landing people on Mars is still part of the NASA goal, but there are many obstacles that must be overcome first. From the first telescope that inspired his passion, to his hopes for mankind's future, von Braun loved space and space technology. His passion and charisma motivated others to accomplish tasks to the best of their ability. Reflecting on the history of the space programs and the space programs of today, von Braun's "Mars Project" but it has taken a different form and progressed at a slower pace. Von Braun was and still is an interesting person. It is of particular interest to the author to continue learning about the works of von Braun and the Space Age. The limitations of yesterday encourage people to reach for the next unknown question to be studied and pursue the impossible.

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About the Author

Brittani Searcy is an undergraduate student at the University of Alabama in Huntsville. She is pursuing a bachelor's degree in aerospace engineering with the graduation date of May 2015. She plans to attend graduate school studying propulsion and/or astrophysics. After graduation, Ms. Searcy plans to work on space science and technology with NASA or a private aerospace company.

References

[1] Erik Bergaust, *Wernher von Braun: the Authoritative and Definitive Biographical Profile of the Father of Modern Space Flight* (Washington, D.C.: National Space Institute, 1976).

[2] Wernher von Braun, "Dedication Alabama Space and Rocket Center" (Huntsville, Alabama: U.S. Space and Rocket Center Archives, 17 March 1970).

[3] Wernher von Braun, *First Men to the Moon* (New York: Holt, Rinehart and Winston, 1960).

[4] Erik Bergaust, *Reaching for the Stars: A Biography of the Great Pioneer in Space Exploration, Wernher von Braun* (Garden City, New York: Double Day, 1960).

[5] Wernher von Braun, "Space Exploration in the Seventies," (Decatur: U.S. Space and Rocket Center Archives, 3 November 1969).

[6] Wernher von Braun, *The Mars Project* (Urbana, Illinois: University of Illinois Press, 1991).

[7] Ed Buckbee, "WVB Special for – The Huntsville Times," *The '60s – Working for the Rocket Man* (15 February 2012).

[8] John F. Kennedy, "John F. Kennedy Moon Speech—Rice Stadium." *NASA JSC* (12 September 1962). http://www.er.jsc.nasa.gov/seh/ricetalk.htm (accessed July 2012).

[9] Willy Ley and Wernher von Braun, *The Exploration of Mars* (New York City: Viking Press, 1956).

[10] NASA, NASA—Station and Shuttle. http://www.nasa.gov/topics/shuttle_station/in dex.html (accessed July 21, 2012).

[11] Michael J. Neufeld, *Von Braun: Dreamer of Space, Engineer of War* (New York: Alfred A. Knopf, 2007).

[12] Ernst Stuhlinger and Frederick I. Ordway III, *Wernher von Braun: Crusader for Space* (Malabar, Florida: Krieger Publishing, 1994).