Linda
Dawson

THE POLITICS AND PERILS OF SPACE EXPLORATION

Who Will Compete, Who Will Dominate?

Springer

Springer Praxis Books

More information about this series at http://www.springer.com/series/4097

Linda Dawson

The Politics and Perils of Space Exploration

Who Will Compete, Who Will Dominate?

Springer

Linda Dawson
Interdisciplinary Arts and Sciences
University of Washington
Tacoma, WA, USA

Springer Praxis Books
ISBN 978-3-319-38811-3 ISBN 978-3-319-38813-7 (eBook)
DOI 10.1007/978-3-319-38813-7

Library of Congress Control Number: 2016948726

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

To my family - Mom and Dad, my sisters Judi and Patti, and my husband Allan.

Preface

One day I asked my college students (not science majors) how their cell phone transmits and receives data. Several students knew that satellites were involved but didn't understand the underlying concepts of geosynchronous orbits and how objects can stay in position over the same region as they circle Earth. In my History and Science of Space Exploration class, I had a student who thought Lance Armstrong was the first man on the Moon, as well as someone else who defined the concept of a vacuum in space as somehow involving sucking air out of an object, Hoover style.

Maybe they were just joking, but it's not big news that students aren't aware of how science works or affects our everyday life. It is, however, disappointing to me that students have so little knowledge of outer space, satellites, our Solar System, and a basic knowledge of the history of space exploration. The students were unaware of a human presence in the International Space Station, how they get there, why they are there, and if NASA still existed. In addition, we were clearly talking about the "history" of space exploration. It was no longer current news that inspired them, although many were enthusiastic about deep space exploration, fueled by science fiction, both in books and movies. I was the only one in the classroom who had actually lived through and experienced the space race up through the space shuttle and the International Space Station. Being aware enough to experience human space exploration from its start to current day has given me a unique perspective.

I wanted to write this book for a number of reasons. I felt that if my students were confused about the existence of NASA today and its relationship to private space enterprises, then others were most likely equally confused. In addition, I wanted to write about the one subject that still inspires me. Through all of the education and jobs I have had, I have always loved airplanes, rockets, and the space program. The underlying focus of my career has been science and technology. A visit to Cape Canaveral early in college inspired me to study space exploration through aerospace engineering. The Moon race fueled my enthusiasm and helped me succeed through the difficult engineering curriculum at MIT, George Washington University, and the University of Washington. I have always kept a connection with space. This project is one more way of exploring more about the interconnections of international space exploration and keeping the subject fresh and alive in my life.

My goal for this book is to provide some insight into current efforts in space exploration, primarily manned efforts. During the space race, the players and the objectives were straightforward, but today, dozens of countries have participated in some aspect of space. Many countries are interested in scientific exploration, security, and communications. Only a few can support the high price of manned missions, which have been confined to low-Earth orbit since the last Moon mission. The relationships between the space programs and their goals are varied and often determined by the resources available. The complexities can often be simplified by looking at regional goals rather than worldwide ambitions. Shared objectives can be combined in partnership efforts. As in other aspects of combined efforts, power and achievement can be accomplished by joining forces and available resources.

Another objective in writing this book is to address how politics has affected the direction of the American space program. Whether it is international or local politics, it is clear that government programs follow government priorities and their associated funding. Success of the Apollo program was one of the most important priorities for U.S. government funding in the 1960s. Our national and international priorities have gone through major changes. Recent focus on military and wartime efforts in the Middle East has depleted the available budget for space efforts. The dependence of NASA and the space program on government funding resulted in limited resources devoted to space missions and space science research. Other types of funding and public support were needed to support more robust space activities. Because of strong public interest and entrepreneurs that were visionaries, a number of small, medium, and large space-related businesses started development on a variety of systems that are crucial to space travel taking the next step.

My career in aerospace engineering includes working at NASA in Houston on the space shuttle program for years prior to the first launch and past the first couple of launches. I was hired to be an Aeronautical Flight Controller for Mission Control. This is the first vehicle that would operate as an airplane on re-entry, requiring the development of a series of operational tools. The space shuttle orbiter vehicle was already designed, developed, and being built in the mid- to late 1970s. When I was hired by NASA, the prototype *Enterprise* was about to be transported and drop-tested from a 747 airplane to test its glide capabilities. I became familiar with the shuttle vehicle and NASA operations and came to understand how stable the orbiter vehicle would be during its re-entry maneuvers. After initiating a de-orbit burn, the orbiter would go through a series of S-turns designed to slow the spacecraft down prior to landing. No other combination airplane/spacecraft had flown before at hypersonic speeds outside of Earth's atmosphere. There were a lot of unknowns. My group investigated other hypersonic aircraft such as the SR-71, the X-15, and experimental lifting bodies to gain insight into the behavior of the orbiter as a glider. As it turned out, the orbiter vehicle was very stable and never became unstable in its descent.

One of my major tasks at NASA was to help develop the flight rules for the orbiter primarily for entry operations in addition to an abort re-entry. The development of these rules required participation in extensive simulations for de-orbit and re-entry. I developed and conducted some of these studies using a re-entry simulator flown by shuttle astronauts. Another component of my job was to estimate how much fuel was necessary to control the vehicle in case of stability problems. After the de-orbit burn, the only control for the orbiter vehicle comes from small reaction control jets that were used for orbital maneuvering and control during entry or orbit maneuvers in the highest part of the atmosphere. If a control jet fails or another control problem requires a jet to stay on or off, vehicle control is maintained by the opposite reaction control jets, staying on to compensate and maintain control. This type of failure uses an extra quantity of fuel. To conserve fuel and save weight, only so many of these malfunctions can be accommodated. Therefore, the failures are prioritized as the most or least likely. After extensive simulations, the final entry fuel budget reflected my simulation study for entry failures.

The final component to my training as a flight controller involved a series of extensive integrated simulations prior to the first shuttle launch. The purpose of these simulations was to verify all systems were being monitored properly and if one or more systems failed, that the appropriate steps were taken to assist the crew and fix the problem. The truth is, for launch and re-entry, there is little that flight controllers could recommend that would be transmitted to the crew in a timely fashion. There were some issues that could be addressed if there was sufficient time during noncritical phases of the mission, such as while the vehicle was in orbit.

After the first shuttle was launched, it was thought that some tiles might have been knocked loose off of the thermal protection system on the bottom of the orbiter. The resulting discussions among flight controllers and their support staff resulted in no action being taken, but there was little that could be done anyway. The situation in part reminded me of John Glenn's flight when a faulty sensor indicated that the heat shield was loose which could put the vehicle in jeopardy of being burned up upon re-entry. It was at first decided during that mission that John Glenn didn't need to know these facts if there was nothing to be done to solve the problem. This would not be the only time that the "no news is good news" approach was used for spaceflights when there were no available remedies for possible malfunctions. Every time a possible disaster was averted, it seemed like the issue was forgotten and the underlying problems were never fully addressed.

The thermal protection tiles were always a critical component for vehicle safety upon re-entry, and there was consistent damage to the tiles from the fuel tank insulation materials hitting some parts of the rest of the vehicle during launch, starting with the first shuttle launch. Eventually, the worst possible scenario did happen. Tiles were damaged on liftoff on a critical area of the orbiter wing, resulting in the fatal re-entry disintegration of the *Columbia* on February 1, 2003. I bring this particular case up because I was involved in the original discussions of the thermal protection tiles during the first shuttle mission. At that time, it was determined that the crew was not in danger—most likely. However, there were a lot of unknowns and it had been simulated that missing tiles in critical locations on the wings could cause a "zipper" effect, allowing extreme heat to travel rapidly through the wing and compromise the vehicle. In the case of the *Columbia*, that exact case did happen, and the wing structurally failed. After the *Columbia* tragedy, a method was put into place to investigate suspected tile damage by utilizing cameras that would view the underside of the orbiter while the vehicle was in orbit. A crew spacewalk to repair the tile would be conducted if necessary, and if the damage could not be repaired, the orbiter would rendezvous with the ISS and wait for a rescue mission. This was not a high tech solution, and yet, why NASA didn't employ these methods earlier in the shuttle program is a mystery.

I have the same feeling when I think about my colleague Dick Scobee and the other astronauts who lost their lives in the *Challenger*. Again, a known problem in the solid rocket booster seals was ignored because it didn't result in tragedy yet, until it did….on January 28, 1986. When I worked at NASA, none of my colleagues were knowledgeable in solid rocket booster technology. Morton Thiokol had the expertise necessary to build reliable rockets and determine safe conditions for launch. Warnings were ignored on that cold January morning, and the worst possible result occurred. What hurt the most was that later, it was discovered that the crew compartment was still intact, and the astronauts were at least initially aware of their dilemma for at least some time after the explosion. Several seconds later, the compartment impacted with the ocean, which killed them all. I no longer worked at NASA at that time, but that didn't help the anger and hurt feelings that a disaster might have been avoided. In addition, the crew compartment had no chance of survival, no parachute, and no control mechanism for soft landing in the water. The remainder of the shuttle launches still had no way for the astronauts to survive under similar circumstances in the launch sequence. It was determined that upgrades were too expensive and would add too much weight to the launch vehicle. Luck prevailed, and no other similar launch accidents happened.

My work experiences at NASA demonstrated the positive and negative of the way decisions were made in the shuttle program, which I think was an extension of other programs that came before. Funding and scheduling pressure was a constant in all programs. As it turned out, it was not the failures of some of the more complex or cutting-edge systems that caused these fatal accidents but rather, existing, nagging unsolved problems and the breakdown of human communication and decision-making. Time will tell if these same sorts of issues affect future NASA or private enterprise endeavors.

It is important to focus on the positive effects of these space efforts and understand that focusing on space science and the investigation of celestial bodies is essential for the future of humankind and the preservation and betterment of Earth. Spaceflight is as exciting as it is dangerous, which is why so many people are drawn to it, both in reality and in their love of science fiction.

University of Washington Linda Dawson
Tacoma, WA

Acknowledgements

I would like to thank Nora Rawn of Springer Publishers for giving me a chance to tell this story. Also, my sister Judi Brodman for her edits and encouragement and my husband Allan for his constant support with this project, even though it meant giving up weekend getaways and vacations.

Contents

About the Author

Linda Dawson received her B.S. in Aerospace Engineering from MIT and an M.S. in Aeronautics and Astronautics from George Washington University at NASA Langley Research Center in addition to completing post-graduate studies in Aerospace Engineering at the University of Washington. She is a Senior Lecturer in Physical Science and Statistics at the University of Washington, Tacoma. Dawson served as Aerodynamics Officer for the NASA Houston Mission Control Center Ascent and Entry Flight Control Teams during the first space shuttle mission (see picture below). During orbital phases, she served as an advisor on the impact of system failures on the orbiter's re-entry trajectory and configuration. From re-entry through touchdown, she was responsible for monitoring the orbiter's stability and control, advising the crew of any necessary corrective actions. Additionally, she serves on the Education Committee and the Space Committee for the Museum of Flight in Seattle, WA.


FDO
220 FDO

1

The New Space Race

Keywords Asteroid Redirect Mission • Chang'e spacecraft • Charles Bolden • Cold War • European Space Agency (ESA) • NASA • NASA Authorization Act • RD-180 • Space Act Agreements (SAA) • Space Exploration Technologies Corporation (SpaceX) • Space Launch System (SLS) • Space race • Space shuttle • Sputnik

> "Space exploration is a force of nature unto itself that no other force in society can rival. Not only does that get people interested in sciences and all the related fields, [but] it transforms the culture into one that values science and technology, and that's the culture that innovates." [1]
>
> –Neil Degrasse Tyson (2012)

There is no longer a definable space race. It ended with the US landing on the Moon and the first human (Neil Armstrong) walking on its surface on July 20, 1969. The space race of the 60s was a clear political and technological race to the Moon between countries representing competing ideologies—democracy in the United States and communism in the Soviet Union. It was an exciting and tense time with political overtones and aggressive posturing that threatened the possibility of nuclear war.

Resources were plentiful in the Moon race due to these external geopolitical pressures ($7–$9 billion over the 5 years following 1961). Given almost unlimited resources in 60s dollars, it became more of a technological race against time. The endgame was succinctly stated by President Kennedy, in a

[1] Tyson, Neil Degrasse. 2012. Space chronicles: why exploring space still matters [audio – radio]. NPR Radio. [Internet] [cited 2016 Mar 17]. Available from: http://www.npr.org/2012/02/27/147351252/space-chronicles-why-exploring-space-still-matters.

L. Dawson, *The Politics and Perils of Space Exploration*,
Springer Praxis Books, DOI 10.1007/978-3-319-38813-7_1

speech to Congress on May 25, 1961: "This nation should commit itself to achieving the goal, before the decade is out, of landing a man on the Moon and returning him safely to Earth."[2] The rest, as they say, is history.

Since the great space race ended, there have been no comparable challenges for the US space program. Progress has continued, but at a slower pace. There have been many achievements and benefits to society from NASA and ESA ventures such as the space shuttle program, the International Space Station, unmanned missions to planets and comets, and the Hubble Telescope's amazing views of the universe, to name just a few. Ambitious new visions are now being posed by commercial endeavors, some in response to prizes offered by NASA. These may not be of the same scale as the 60s space race, but any of these efforts could impact the future of space exploration and contribute to a political advantage in the United States.

The world players in space exploration have changed slightly today, with the traditional superpowers still leading the pack in space efforts—the United States, China, Russia, Japan and the combined European Union. Many national efforts are focused on becoming a regional leader in space technology in order to gain an advantage in Earth science, security and communication. The world situation in some regions is tense, with some countries once again using missiles to demonstrate their military force. In this environment, collaboration among nations is necessary to unite countries in working towards their regional and international goals and prevent any further buildup of aggression in space. Especially as space mining technologies continue to develop, clear operating principles will be needed to prevent strife.

In general, however, momentum is shifting away from national space agencies. The individual faces behind the new space frontier are ambitious businessmen and entrepreneurs. Many grew up as "space cadets," in love with the idea of space travel, launching model rockets in the backyard and thinking that they could build their own rockets someday. With start-up companies and support from NASA, the dream is becoming reality. It will be interesting to watch how this combination of NASA, private enterprise, and other partnerships will combine and create an exciting future for us all.

The future of space exploration is bright. The industry is on the verge of exploring a new frontier—Mars and beyond—with both manned and unmanned missions that will utilize new methods and spacecraft technology developed by a host of new participants. All global citizens will be benefactors of this next phase of Earth's journey into outer space.

---

[2] John F. Kennedy Presidential Library and Museum. [Internet] [cited 2015 June 07]. Available from: http://www.jfklibrary.org/JFK/JFK-in-History/Space-Program.aspx.

The Changing Landscape of Outer Space

Over 50 years ago, outer space was seen as the next frontier for humans to investigate and explore. In addition to other benefits, travel into space would give researchers valuable information about our own planet and what lies beyond. High altitude measurement devices could transmit, for example, more accurate weather data and observational images. Not much was known about the outer space environment and whether humans could even survive travel back and forth from space. It truly was an unknown environment filled only with images from science fiction depictions.

The political landscape after World War II became tense with the development of the Cold War. America initially approached space exploration somewhat cautiously so as not too appear aggressive. The USSR, however, did not have the same strategy and instead pushed forward aggressively, launching Sputnik, the first artificial satellite into orbit. The space race was born, and Americans felt and heard the humiliation every 90 minutes as Sputnik passed overhead, beeping in a foreign language. The next 10–15 years were filled with a series of space firsts, along with each nation's individual successes and failures. The initial rush to explore and dominate outer space was driven more politically than scientifically, and even today, as we move forward into a new age of space development, many of the initiatives are still driven by political motives.

Decades after the space race officially ended, the world today stands at the threshold of a second Space Age and a new type of space race. In the decades after the Moon landing, entire networks of communication and defense satellites were launched, both bringing the world much closer together and placing it under constant surveillance. Humans have lived and worked in outer space for long periods of time, allowing scientists to study long-term effects of experiencing nearly zero gravity aboard space stations. Hundreds of significant experiments have been conducted in laboratories, either in the payload bay of the space shuttle or in space stations, most recently the cooperative effort of the International Space Station. There is now an increased awareness of space debris. So many objects have been placed in orbit around Earth that there is concern about the irreparable damage that satellites or other orbital debris can impact on other spacecraft or stations in orbit. Several countries have participated in both manned and unmanned missions in space, demonstrating a variety of initiatives covering the many facets and applications of outer space exploration.

In the United States, innovative NASA and private sector programs are transforming the space industry. The opportunities for exploration and economic development of the Solar System are expanding. Space technologies have become an integral part of our economy—telecommunications, imaging, and global positioning satellites all formed on the basis of over 50 years of research and development by NASA and other government agencies such as the Department of Defense. Over the next decades, NASA will continue to provide the programs and investments necessary to expand our missions farther from Earth.

NASA's next objectives for exploration include visits to asteroids and Mars, tasks involving more complex technologies and planning than any previous space missions. Successful entrepreneurs worldwide have spent millions of dollars to develop systems that are aimed at exploring and exploiting outer space. More than 50 years after NASA was created, its goal is no longer just to reach a destination in outer space but rather to develop the capabilities that will allow Americans to explore and expand their economic horizons beyond Earth. With the combined talents of government and the private sector, the next journeys beyond Earth will come quicker and will integrate new industries and technologies in the process.

NASA has a legislated responsibility to "encourage, to the maximum extent possible, the fullest commercial use of space."[3] As part of this responsibility, NASA has partnered with private sector individuals and US companies investing in space exploration. In addition to American efforts in space exploration, several countries are now competing for international and regional prestige in the demonstration of space technologies and space science. A new Space Age is well on its way.

The Politics of Space Exploration: NASA and the United States

Space exploration goals and missions are formulated through scientific analysis and agenda-setting by researchers, budget and policy decisions of governments, and through private industry. NASA's funding of colonization or deep space exploration is based on the priorities of the government of the United States in terms of dispensing resources. Each budget item requires explanation and support, and there is also lobbying for the highest level of funding.

The process for budget approval starts with the president submitting an annual budget request to Congress. Leading up to this, all appropriate

[3] NASA.gov. National Aeronautics and Space Act. [Internet] NASA.gov Pub. L. No. 111-314; Dec. 18, 2010 [cited 2016 Mar 22]. Available from: https://www.nasa.gov/offices/ogc/about/space_act1.html

agencies have reviewed their programs and submitted estimates of resources necessary to accomplish their goals. Review committees assemble the requests and discuss priorities with the president, resulting in the final budget request. This process can take an entire year and is a complex process with many levels of review.

The upcoming space budget has been proposed through the NASA Authorization Act for 2016 and 2017, a US law that authorizes NASA's budget with specific line items and policy guidelines. The budget has to pass through Congress for editing before final approval. The proposed budget commits to the development of future efforts such as the Space Launch System (SLS) and Orion. At the same time, "it supports our commitment to once more launching American astronauts, on American rockets, from American soil," states the bill's lead sponsor, Congressman Steven Palazzo (R-Miss.).[4]

The Authorization Act demonstrates strong Congressional support for NASA's success, reiterating the importance of American leadership in space. It aims at regaining national pride in space exploration and enforcing national security through a clear and demonstrated financial plan that supports a clear roadmap for future space efforts. The majority of the funds proposed in the 2016–2017 NASA budget are slated for space exploration and spaceflight technology. The US House of Representative's Committee on Science, Space, and Technology released a statement in April 2015 supporting a more balanced budget that reflects the core mission of NASA with programs in science, aeronautics and spaceflight. It also stated that Mars should be NASA's primary goal.

Chairman Lamar Smith stated "For more than 50 years, the US has led the world in space exploration. We must ensure that the US continues to lead in space for the next 50 years. Astronauts like John Glenn, Neil Armstrong, Buzz Aldrin, Gene Cernan and Sally Ride are household names and national heroes. And today's astronauts inspire American students to study science, technology, engineering, and mathematics and to reach for the stars. Space exploration is an investment we must continue to make in our nation's future."[5]

The bill made its way through the House of Representatives in April 2015 with markups for proposed cuts. NASA Administrator Charles Bolden, an ex-astronaut who has viewed our planet from outer space, responded to the planned budget reductions that he felt would severely impact NASA's Earth science program: "The NASA authorization bill making its way through the House of Representatives guts our Earth science program and threatens to

[4] Committee Plans to Restore Balance to NASA's Budget. US Official News. April 27, 2015.

[5] Committee Plans to Restore Balance to NASA's Budget. US Official News. April 27, 2015.