

National Aeronautics and
Space Administration



Toward a History *of the* Space Shuttle

An Annotated Bibliography

Part 2, 1992–2011

TOWARD A HISTORY OF THE SPACE SHUTTLE

AN ANNOTATED BIBLIOGRAPHY, PART 2 (1992–2011)

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PREFACE

This annotated bibliography is a continuation of *Toward a History of the Space Shuttle: An Annotated Bibliography*, compiled by Roger D. Launius and Aaron K. Gillette, and published by NASA as Monographs in Aerospace History, Number 1 in December 1992 (available online at <http://history.nasa.gov/Shuttlebib/contents.html>). The Launius/Gillette volume contains those works published between the early days of the United States' manned spaceflight program in the 1970s through 1991. The articles included in the first volume were judged to be most essential for researchers writing on the Space Shuttle's history. The current (second) volume is intended as a follow-on to the first volume. It includes key articles, books, hearings, and U.S. government publications published on the Shuttle between 1992 and the end of the Shuttle program in 2011. The material is arranged according to theme, including: general works, precursors to the Shuttle, the decision to build the Space Shuttle, its design and development, operations, and management of the Space Shuttle program. Other topics covered include: the *Challenger* and *Columbia* accidents, as well as the use of the Space Shuttle in building and servicing the Hubble Space Telescope and the International Space Station; science on the Space Shuttle; commercial and military uses of the Space Shuttle; and the Space Shuttle's role in international relations, including its use in connection with the Soviet *Mir* space station. This volume also includes juvenile literature on the Shuttle, as well as information about the Shuttle astronauts, memoirs about the Shuttle, and the end of the Space Shuttle program. A glossary of NASA abbreviations is included as well.

The contents of this bibliography were collected from a number of publications, including: *Ad Astra*, *Air & Space*, *Aviation Week & Space Technology*, *Economist*, *Interavia*, *Nature*, *New Scientist*, *New Yorker*, *New York Times*, *Newsweek*, *Popular Science*, *Science*, *Spaceflight*, *Space News*, *Space Policy*, *Technology and Culture*, *Time*, and *Washington Post*. Relevant publications of the Congressional Budget Office, congressional hearings, Congressional Research Service, and Government Accountability Office are included as well.

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NASA ABBREVIATIONS

AAS	American Astronomical Society
ANDE	Atmospheric Neutral Density Experiment
ARC	Ames Research Center
ASAP	Aerospace Safety Advisory Panel
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
ATLAS	Atmospheric Laboratory for Applications and Science
CAIB	Columbia Accident Investigation Board
CBO	Congressional Budget Office
CEV	crew exploration vehicle
CLV	crew launch vehicle
COTS	Commercial Orbital Transportation System
CSA	Canadian Space Agency
CRS	Congressional Research Service
DFRC	Dryden Flight Research Center
DOD	U.S. Department of Defense
EDT	Eastern Daylight Time
ELC	Express Logistics Carrier
ELV	expendable launch vehicle
EPOCH	Extrasolar Planet Observations and Characterization
EPOXI	Extrasolar Planet Observations and Characterization (EPOCH) and Deep Impact Extended Investigation (DIXI)
ESA	European Space Agency
EVA	extravehicular activity
GAO	Government Accountability Office
GPS	global positioning system
GRACE	Gravity Recovery and Climate Experiment
GSFC	Goddard Space Flight Center
HST	Hubble Space Telescope
IML	International Microgravity Laboratory
IRVE	Inflatable Re-entry Vehicle Experiment
ISRO	Indian Space Research Organisation
ISS	International Space Station
JEF	Japanese Exposed Facility
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Center
JWST	James Webb Space Telescope
KARI	Korea Aerospace Research Institute
KSC	Kennedy Space Center
KSLV	Korea Space Launch Vehicle
LaRC	Langley Research Center
LAS	launch-abort system
LIDAR	laser-imaging detection and ranging
LITE	Lidar In Space Technology Experiment
MISSE	Materials International Space Station Experiments

NASA ABBREVIATIONS

MLAS	Max Launch Abort System
MODIS	Moderate Resolution Imagine Spectroradiometer
MOU	memorandum of understanding
MRM	Mini Research Module
MSFC	Marshall Space Flight Center
MSL	Microgravity Science Laboratory
NAC	NASA Advisory Council
NAS	National Academy of Sciences
NASDA	National Space Development Agency of Japan
NCAR	National Center for Atmospheric Research
NESC	NASA's Engineering and Safety Center
NGLLXPC	Northrop Grumman Lunar Lander X Prize Challenge
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
NSF	National Science Foundation
OAST	Office of Aeronautics and Space Technology
OPM	Office of Personnel Management
PORT	Post-Landing Orion Recovery Test
RLV	reusable launch vehicle
RTF	Return to Flight
SMD	Science Mission Directorate
SRB	solid rocket booster
SRL	Space Radar Laboratory
SSC	Stennis Space Center
SSME	Space Shuttle main engine
SST	Spitzer Space Telescope
STS	Space Transportation System
STScI	Space Telescope Science Institute
TDRS	Tracking and Data Relay Satellites
Titan	Telemetry, Information, Transfer, and Attitude Navigation
USML	United States Microgravity Laboratory
USMP	U.S. Microgravity Payload
WFF	Wallops Flight Facility
WSF	Wake Shield Facility

CHAPTER 1—GENERAL WORKS

Asker, James R. “At 15, a Safer, Cheaper Shuttle.” *Aviation Week & Space Technology*, 8 April 1996. This article examines the Space Shuttle program’s status in 1996, the fifteenth anniversary of its creation, comparing it to the program as originally envisioned—as an inexpensive means of access to space. The author discusses how the program has changed over time, explaining how it has failed to meet its early goals.

Bergin, Mark. *Space Shuttle*. New York: Franklin Watts, 1999. This book, recommended for elementary and junior high school readers, follows the development of the Space Shuttle program from the early years to the present day, covering construction of the Shuttle and missions in space, including takeoff, reentry, and landing.

Bizony, Piers. *The Space Shuttle: Celebrating Thirty Years of NASA’s First Space Plane*. Minneapolis: Zenith Press—MBI Publishing, 2011. This illustrated book marks a special moment in history: STS-134, the final mission of Space Shuttle *Endeavour*. The book provides a retrospective of all 134 Space Shuttle missions, including the Shuttle’s final flight. In addition, the author discusses the development and design of the Space Shuttle, its technical specifications, and the details of its major assemblies and subassemblies.

Cowling, Tim. *The Space Shuttle*. Videocassette (VHS). Bethesda, MD: Program Enterprises, 1994. This video describes the tasks associated with the Space Shuttles’ safe launch and return to Earth. Individuals around the world recount how they help make NASA and the Space Shuttle program work, describing jobs ranging from cleaning the Shuttle to intricate computer programming.

Dailey, J. R. “The First Space Shuttle.” *Air & Space*, July 2004. This article examines the restoration of Space Shuttle *Enterprise* for exhibition at the Smithsonian Institution’s Udvar-Hazy Center near Washington Dulles International Airport in Chantilly, Virginia, outside Washington, DC.

Drendel, Lou, and Ernesto Cumpian. *Walk Around Space Shuttle*. Carrollton, Texas: Squadron Signal Publications, 1999. This book provides a comprehensive collection of photographs of NASA Space Shuttles, including close-up photographic views of the Space Shuttles, with detailed captions.

Easterbrook, Gregg. “The Space Shuttle Must Be Stopped.” *Time*, 25 July 2005. The author argues that the Space Shuttle program is too risky and too costly to maintain. He contends that Shuttle budgets use up funds that NASA could invest in developing a modern, safe, and less expensive spacecraft.

Exciting Simulations and Iceberg Interactive. *Space Shuttle Mission Simulator*. Space Simulation Computer Game. Haarlem, The Netherlands: Iceberg Interactive, 2010. This computer program enables users to experience the liftoff shakes and the roar of the engines, from the seat of the Space Shuttle commander or pilot. Users can perform simulated mission

procedures, such as pressing buttons, rotating knobs, controlling the computer, and manually guiding the Shuttle to a safe landing.

Ferris, Timothy. "Earthbound." *New Yorker*, 1 August 1994. The author claims that the Space Shuttle program takes too much of NASA's budget and suggests that NASA should focus on exploring Mars.

Follett Software Company and Amazing Media. *Space Shuttle*. Cupertino, CA: KidSoft, 1996. DVD. This DVD program contains a multimedia introduction to the Space Shuttle program, including descriptions of space vehicles, equipment, and crews; orientation and training at NASA's Johnson Space Center; and details of living and working in space on 53 NASA missions.

Green, Barbara E. *United States Space Shuttle Firsts, 25th Anniversary*. KSC Historical Report 19, Library Archives, Kennedy Space Center, NASA, Florida, April 2006. The author compiled this summary of the Space Shuttle program from various reference publications available in the Library Archives of NASA's Kennedy Space Center. The report features photographs and brief information about significant events in the Space Shuttle program, from flights STS-1 to STS-114 (1981–2005). The report covers the Shuttle's first free flight in 1977; the first Shuttle launch in 1981; the first flight by an American woman astronaut, Sally K. Ride, in 1983; and the return to space of astronaut and U.S. Senator John H. Glenn Jr. in 1998.

Handberg, Roger, Joan Johnson-Freese, and George Moore. "The Myth of Presidential Attention to Space Policy." *Technology in Society* 17, no. 4 (27 December 1999): 337–348. The authors propose that, ever since President John F. Kennedy launched the race to place a U.S. astronaut on the Moon, the public has tended to regard the president as the prime mover behind the United States' civilian space program. The article argues that NASA's implicit goal throughout the years has been to recapture that original "magical" moment, suggesting that, besides working to make the space program economically viable, NASA must find ways to appeal to policymakers and the public, capturing their imagination and harnessing their support.

Harland, David M. *The Space Shuttle: Roles, Missions and Accomplishments*. New York: Wiley, 1998. This comprehensive book about the Space Shuttle describes its origins, operations, and explorations, as well as discussing weightlessness, exploration, and outposts. The book also contains a Space Shuttle mission log, glossary, and bibliography.

Hoversten, Paul. "The Truck: Satellites, Experiments, Space Station Parts—The Space Shuttle Hauled It All." *Air & Space*, August 2010. In this article discussing Space Shuttle payloads and the work carried out on the Shuttle, the author details the numerous objects the Shuttle has carried into space, including the Magellan Venus probe in 1989, the Galileo Jupiter probe in 1989, the HST, and pieces of the ISS.

- Kay, W. D. “Democracy and Super Technologies: The Politics of the Space Shuttle and Space Station Freedom.” *Science, Technology and Human Values* 19, no. 2 (April 1994): 131–151. Using the U.S. Space Shuttle program and the Space Station Freedom program as examples, the author argues that the problems of technology-based projects like those of the U.S. space program are deeply rooted in the American political process itself. The article explains that, in the United States, political requirements for obtaining approval and funding for large, expensive research and development projects create conditions that reduce the likelihood of the projects’ technological success.
- Klesius, Michael. “The Evolution of the Space Shuttle.” *Air & Space*, July 2010. In this article, the author discusses the history of the Space Shuttle program, explores modifications to the design of the Space Shuttle considered throughout the program, and examines the errors leading to the loss of *Challenger* in January 1986 and *Columbia* in February 2003.
- Launius, Roger D. “Assessing the Legacy of the Space Shuttle.” *Space Policy* 22, no. 4 (November 2006): 226–234. This article describes the Space Shuttle as a constraint on other NASA space options, a flexible space-access vehicle, a platform for science, and a symbol of American technological prowess. The author argues that the Space Shuttle deserves a positive assessment because it helped foster development of spaceflight.
- Lee, Wayne. *To Rise from Earth: An Easy-To-Understand Guide to Spaceflight*. 2nd ed. New York: Facts on File, 2000. The author explains the principles of rocket propulsion and discusses how the Space Shuttle achieves or changes orbit, describing the Shuttle’s rockets and orbital mechanics. The book includes a chapter on space history, which traces the space milestones of the United States and Russia, and offers insight into the future of Mars exploration.
- “Many Happy Returns? NASA at 50.” *Economist*, 26 July 2008. The Space Shuttle and the ISS consume two-thirds of NASA’s budget for piloted spaceflight. Claiming that the Space Shuttle program has been far more expensive than the throw-away rockets it was intended to replace, the author of this article argues that NASA does not justify the worth of its programs simply in terms of its balance sheet.
- Morring, Frank, Jr. “Because It’s Hard.” *Aviation Week & Space Technology*, 29 September 2008. This article looks at issues facing NASA as it celebrates its 50th anniversary amid shifting national priorities in an ever-changing geopolitical scene.
- “NASA Unveils Future Space Exploration Architecture.” *Interavia Business & Technology*, Autumn 2005. This article unveils the architecture of NASA’s future space exploration, explaining NASA’s plan to use an improved, blunt-body capsule for its next generation of spacecraft. The new spacecraft will have a shorter development time, reduced reentry loads, increased landing stability, safe travel for up to six crew members, and the ability to dock at the ISS. The new system will have two primary launch vehicles—the crew-launch vehicle and the lunar heavy-cargo launch vehicle.

Official NASA Films Documenting the U.S. in Space. 5 vols. Videocassette (VHS). Burbank, CA: Warner Home Video, 1993. This five-volume videocassette collection of NASA films documents the U.S. space program. Two of the five volumes cover the Space Shuttle program. Volume 2, “Space Shuttle: From the Beginning,” traces the history of the program, from the initial research and development of the design for a reusable spacecraft, through the first Shuttle missions. Volume 3, “Space Shuttle: Training, Facilities, Space Station,” follows a Space Shuttle mission crew and vehicle from training to the day of the launch. The remaining volumes in the set cover other NASA programs.

“Old, Unsafe, and Costly.” *Economist*, 30 August 2003. The article comments on proposals to discontinue the Space Shuttle program because of problems in Shuttle design, the costs of the program, and the safety risk of launching these space vehicles into space. In addition, the article discusses the possibility that the Space Shuttle program is having a negative effect on the development of a private space industry. The author believes that the Shuttle program has failed and that NASA should concentrate on developing high-risk technologies with the potential to transform routine space travel for people and equipment.

Pace, Scott. “Challenges to US Space Sustainability.” *Space Policy* 25, no. 3 (August 2009): 156–159. The author describes space program sustainability issues over the coming decade, such as U.S. human access to space and the U.S. space industrial base, as well as long-term sustainability issues, such as protecting the space environment and the effects of space weather.

Pelton, Joseph N. “The Space Shuttle—Evaluating and American Icon.” *Space Policy* 26, no. 4 (November 2010): 246–248. The author details key U.S. space policy decisions, as they relate to the Space Shuttle, and reviews the Space Shuttle program, including its origins in the White House of the President Richard M. Nixon administration. The article discusses the U.S. space transportation system, deployment of the ISS, the HST, and classified missions.

Pielke, Roger A., Jr. “Space Shuttle Value Open to Interpretation.” *Aviation Week & Space Technology*, 26 July 1993. The article explains Space Shuttle costs from the point of view of a taxpayer, a space policymaker, and a national policymaker.

Review of U.S. Human Space Flight Plans Committee. “Seeking A Human Spaceflight Program Worthy of A Great Nation.” Final Report, Washington, DC, October 2009. http://www.nasa.gov/pdf/396093main_HSF_Cmte_FinalReport.pdf (accessed 10 April 2012). The result of the White House Office of Science and Technology Policy’s call for an independent review of the present and planned human spaceflight program, this report is also known as the “Augustine Report,” after Norman R. Augustine, the chair of the committee that conducted the review. The White House–appointed Review of U.S. Human Space Flight Plans Committee comprised 10 members with diverse professional backgrounds, including scientists, engineers, astronauts, educators, executives of established and new aerospace firms, former presidential appointees, and a retired Air Force General. This report describes the independent review of the current program and

suggests alternatives that would ensure that the nation is pursuing a safe, innovative, affordable, and sustainable trajectory for the future of human spaceflight.

Rumerman, Judith A., Chris Gamble, and Gabriel Okolski. "Space Shuttle." In *U.S. Human Spaceflight: A Record of Achievement, 1961–2006*, 35–74. Monographs in Aerospace History, no. 41. NASA Report no. SP-4541, NASA History Division, Office of External Relations, NASA Headquarters, Washington, DC, December 2007. <http://history.nasa.gov/monograph41.pdf> (accessed 8 March 2012). This chapter of NASA's book on human spaceflight describes Space Shuttle flights STS-1 through STS-116 (1981–2006) and provides information about each Shuttle mission, including crew-member names, Shuttle names, and the purpose of each mission. The chapter also provides a short bibliography on the Shuttle.

Smith, Marcia S. "Space Exploration: Issues Concerning the 'Vision for Space Exploration'." CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 6 September 2005. http://assets.opencrs.com/rpts/RS21720_20050609.pdf (accessed 8 March 2012). This report provides an overview of President George W. Bush's 2004 Vision for Space Exploration and congressional reaction to the Vision, which includes terminating the Space Shuttle program in 2010.

Space Shuttle: A Remarkable Flying Machine. Videocassette (VHS). Houston, Texas: TaLas Enterprises, 1994. This film documents the first historic flight of a Space Shuttle, the U.S. spacecraft *Columbia*, which launched on 12 April 1981. The footage highlights liftoff, the on-board activities of astronauts John W. Young and Robert L. Crippen, and the Shuttle's landing in Rogers Dry Lake bed in California. This file is available for download from: <http://www.archive.org/details/gov.archives.arc.1157922>.

The History of the Space Shuttle. Atlanta, GA: Whitman Publishing, 2012. <http://whitman.com/Inventory/Detail/The-History-of-the-Space-Shuttle> (accessed 10 April 2012). This book recounts the history of NASA's Space Shuttle program, from earliest design and testing of the Shuttle to its historic final launch on 8 July 2011. Each chapter includes links to more than 70 audio and video clips explaining the critical role that the Shuttle has played in establishing a human presence in low Earth orbit, as well as describing Shuttle missions and crews and the experience of eating, sleeping, and living aboard the spacecraft.

The Space Shuttle. DVD. New York: A & E Television Networks and History Channel Club, 2008. This DVD program, containing footage from missions, expert interviews, and computer simulations, describes the Space Shuttle from its conception to its launch, recounting the story of how NASA overcame risks and challenges to make the Space Shuttle a reality.

The Space Shuttle. DVD. New York: Jaffe Productions, Hearst Entertainment, A & E Home Video, New Video Group, and History Channel, 2004. This DVD program details the development of the Space Shuttle from the 1950s to its triumphant launch in 1981. The

program examines the successes and failures of the Shuttle missions and looks at the next generation Shuttle—the futuristic commercial reusable space vehicle X-33 VentureStar.

Tsuruta, Nobuyuki, and Robert Lanchester. *The Space Shuttle*. DVD. Princeton, NJ: Films for the Humanities and Sciences, 2003. This DVD program, an analysis of the Space Shuttle, explains Shuttle technology and shows the functions of the three components of the Space Shuttle system: the orbiter, the external tank, and the solid rocket boosters. The film demonstrates how the orbiter's flight deck functions and explains the operation of its attitude control and orbital maneuvering systems, as well as discussing its payload bay equipped with a Remote Manipulation System.

Vedda, James A. "Space Power." *Ad Astra*, February 2003. This article focuses on the U.S. Congress's behavior toward NASA's human spaceflight programs and the Space Shuttle since the end of the Apollo program, examining how institutional changes in Congress over the previous 30 years could affect policymaking for current and future civil space activities.

[Link to Part 1 \(1970–1991\), Chapter 1—General Works](#)

CHAPTER 2—PRECURSORS

Heppenheimer, T. A. *Countdown: A History of Space Flight*. New York: Wiley, 1999. Taking a historian's view of the space age, the author places the U.S. space program's major achievements, such as the Apollo program, in the context of concurrent political and social developments. The author juxtaposes the space programs of the U.S.S.R. and the United States, providing insights into why the two most powerful nations in the world became embroiled in the costly and politically charged race for space.

Heppenheimer, T. A. *Space Shuttle Decision, 1965–1972*. 2 vols. Washington, DC: Smithsonian Institution Press, 2002. The author looks back at the Space Shuttle's technical antecedents, such as the X-15 rocket plane and rocket-booster technologies. In addition, he illuminates the principal personalities involved in the decision to build the Space Shuttle and considers their motivations. Tracing the development of the myriad designs that preceded the Shuttle concept, he discusses NASA's evolving technical calculations, its fiscal constraints, and the background of political maneuvering that influenced the development of program goals.

Jenkins, Dennis R. *Space Shuttle: The History of Developing the National Space Transportation System, the Beginning Through STS-75*. Marceline, MO: Walsworth Publishing Company, 1997. This book discusses technical approaches to building an RLV or a semi-RLV. In addition, the author explains the history of the Space Shuttle, including its funding, construction, and flights. The book also describes the technology of the Space Shuttle, as it was originally built and as it has been modified through the years.

Launius, Roger D., and Dennis R. Jenkins, eds. *To Reach the High Frontier: A History of U.S. Launch Vehicles*. Lexington, KY: University Press of Kentucky, 2002. Because of the technical challenge of reaching space with chemical rockets, the high costs associated with space launch, the long lead times necessary for scheduling flights, and the poor reliability of the rockets themselves, launch vehicles are the space program's most difficult challenge. This book recounts the history of each type of space-access vehicle developed in the United States since the birth of the space age in 1957. Two chapters cover the Space Shuttle.

Overbye, Dennis. "As Shuttle Era Ends, Dreams of Space Linger." *New York Times*, 5 July 2011. Written on the eve of the final Space Shuttle flight, STS-135, Space Shuttle *Atlantis*'s last mission before retirement, this article reviews the programs that led to development of the Shuttle.

Reed, Dale R., and Darlene Lister. *Wingless Flight: The Lifting Body Story*. Report no. NASA SP-4220, NASA History Division, Office of Policy and Plans, Washington, DC, 1996. <http://history.nasa.gov/SP-4220/sp4220.htm> (accessed 8 March 2012). This book examines the lifting body, a wingless vehicle that was a precursor to the Space Shuttle. This spacecraft flew because of the lift generated by the shape of its fuselage. One of these lifting bodies, the X-24B, shared very similar speed and performance characteristics

with the projected Shuttle spacecraft design. The X-24B was used to collect operational data used in the design and development of the Space Shuttle vehicles.

Rumerman, Judith A., Chris Gamble, and Gabriel Okolski. *U.S. Human Spaceflight: A Record of Achievement, 1961–2006*, 35–74. Monographs in Aerospace History, no. 41. NASA Report no. SP-4541, NASA History Division, Office of External Relations, NASA Headquarters, Washington, DC, December 2007. <http://history.nasa.gov/monograph41.pdf> (accessed 8 March 2012). This reference book contains information on the NASA manned space exploration programs, including the Mercury, Gemini, Apollo, Skylab, and Apollo-Soyuz programs. The book also includes chapters on the Space Shuttle and International Space Station programs. The Space Shuttle chapter describes the program and provides brief descriptions of the first 117 Shuttle flights. The book also contains many black and white photographs and an appendix of Shuttle main payloads.

The Space Shuttle. DVD. New York: A & E Television Networks and History Channel Club, 2008. This DVD program, containing footage from missions, expert interviews, and computer simulations, describes the Space Shuttle from its conception to its launch, recounting the story of how NASA overcame risks and challenges to make the Space Shuttle a reality.

The Space Shuttle. DVD. New York: Jaffe Productions, Hearst Entertainment, A & E Home Video, New Video Group, and History Channel, 2004. This DVD program details the development of the Space Shuttle from the 1950s to its triumphant launch in 1981. The program examines the successes and failures of the Shuttle missions and looks at the next generation Shuttle—the futuristic commercial reusable space vehicle X-33 VentureStar.

Thompson, Milton O. *Flight Research: Problems Encountered and What They Should Teach Us*. With a Background Section by J. D. Hunley. Monographs in Aerospace History no. 22, NASA Report no. SP-2000-4522, NASA History Division, Office of Policy and Plans, NASA Headquarters, Washington, DC, 2000. http://www.nasa.gov/centers/dryden/pdf/88795main_Thompson.pdf (accessed 8 March 2012). This book describes early aeronautic research that helped lay the groundwork for the development of the Space Shuttle. The author discusses aerodynamics, environmental systems, control systems, landing gear, and heating issues.

Thompson, Milton O., and Curtis Peebles. *Flying Without Wings: NASA Lifting Bodies and the Birth of the Space Shuttle*. Washington, DC: Smithsonian Institution, 1999. This book charts the transformation of aircraft into spacecraft, describing the efforts of a small group of NASA pilots and researchers to prove a seemingly impossible aerodynamic concept that would profoundly influence the history of spaceflight. The authors explain how, after the cancellation of the U.S. Air Force's Dyna-Soar Program, the first lifting body projects, such as the Parasev paraglider and the M2-F1, were built on shoestring budgets at Edwards Air Force Base, California, often without the knowledge of officials at the NASA Headquarters.

Wallace, Lane E. “Flights of Discovery: 50 Years at the NASA Dryden Flight Research Center.” NASA Report no. SP-4309, NASA History Series, Washington, DC, 1996. This history of the first 50 years at NASA’s Dryden Flight Research Center captures the spirit of aeronautical research and development from 1946 to 1996, providing insightful accounts of most of the major flight research projects during this period. NASA used Dryden Flight Research Center to engineer and test the Space Shuttle and its precursors.

[Link to Part 1 \(1970–1991\), Chapter 2—Precursors of the Shuttle](#)

CHAPTER 3—THE DECISION TO BUILD THE SPACE SHUTTLE

- Covault, Craig. “Blame It on Nixon; Space Policy Failures Bred NASA Shuttle Promises That Were Unattainable.” *Aviation Week & Space Technology*, 19 March 2007. In this article, Covault discusses the effect on the U.S. space program of President Richard M. Nixon’s 1972 approval of the plan to develop the Space Shuttle. In March 1973, James C. Fletcher of NASA announced that further studies had uncovered additional potential Shuttle uses, and that NASA expected the new uses would increase the program’s cost benefits.
- Gold, Thomas. “Is NASA an Expensive Failure?” *Nature* 366, no. 6457 (23 December 1993): 723. This opinion article decries NASA’s insecure, publicity-seeking policies, which have made a debacle of the U.S. space program. The author notes that, although NASA originally claimed that Space Shuttle space launches would be much cheaper than disposable rocket launches, Shuttle launch costs have actually been much higher than those of unpiloted, disposable boosters. Higher Space Shuttle costs have meant the loss of other NASA projects, such as Mars Orbiter.
- Heppenheimer, T. A. *Space Shuttle Decision, 1965–1972*. Vol. 1 of *History of the Space Shuttle*. The NASA History Series. Washington, DC: Smithsonian Institution Press, 2002. The author looks back at the Space Shuttle’s technical antecedents, such as the X-15 rocket plane and rocket-booster technologies. In addition, he illuminates the principal personalities involved in the decision to build the Space Shuttle and considers their motivations.
- Jenkins, Dennis R. *Space Shuttle: The History of Developing the National Space Transportation System, the Beginning Through STS-75*. Marceline, MO: Walsworth Publishing Company, 1997. This book discusses technical approaches to building an RLV or a semi-RLV. In addition, the author explains the history of the Space Shuttle, including its funding, construction, and flights. The book also describes the technology of the Space Shuttle, as it was originally built and as it has been modified through the years.
- Klesius, Michael. “The Evolution of the Space Shuttle.” *Air & Space*, July 2010. In this article, the author discusses the history of the Space Shuttle program, explores modifications to the design of the Space Shuttle considered throughout the program, and examines the errors leading to the loss of *Challenger* in January 1986 and *Columbia* in February 2003.
- Launius, Roger D. “History Reference Center: NASA and the Decision To Build the Space Shuttle, 1969–72.” *Historian* 57, no. 1 (Autumn 1994): 17. This article describes NASA’s efforts between 1969 and 1972 to create a viable, low-cost Space Shuttle program. Other topics covered include completion of the Apollo mission, NASA’s participation in a political decision-making process, and President Richard M. Nixon’s appointment of the Space Task Group to study possible future projects after the end of the Apollo program.

Temple, L. Parker, III. “Committing to the Shuttle Without Ever Having a National Policy.” *Air Power History*, 22 September 2005. This article claims that President Richard M. Nixon’s original 1969 U.S. space policy never made an explicit commitment to the use of the Space Shuttle for all U.S. launches. The author seeks to understand how the de facto commitment developed, arguing that this policy has nearly led to the United States’ sacrificing its ability to produce expendable launch vehicles. He concludes that a finesse of the policy process was responsible for this outcome.

U.S. General Accounting Office. “1998 NASA Budget: Review of Selected Activities.” Report no. GAO/NSIAD-97-252R, Washington, DC, 30 September 1997. <http://archive.gao.gov/paprpdf/1/159356.pdf> (accessed 8 March 2012). This report reviews NASA’s FY 1998 budget request. The GAO notes that it has identified opportunities to reduce NASA’s FY 1998 budget request by about US\$108 million, primarily involving cutbacks to human spaceflight programs (US\$54.4 million) and mission support (US\$53 million).

Vedda, James A. “Evolution of Executive Branch Space Policy.” *Space Policy* 12, no. 3 (August 1996): 177–192. This article describes space policies enacted by different presidents and explains how these policies affected Space Shuttle development. NASA had originally conceived of the Space Shuttle as a delivery vehicle, but in response to presidential policy changes, NASA developed a Space Shuttle that could function as a laboratory and show economic returns.

Link to Part 1 (1970–1991), Chapter 3—The Shuttle Decision

See also Part 1 (1970–1991), Chapter 8—Shuttle Promotion

CHAPTER 4—DESIGN AND DEVELOPMENT

- Biggs, R. E. *Space Shuttle Main Engine: The First Twenty Years and Beyond*. American Astronautical Society History Series, vol. 29. San Diego, CA: Univelt, 2008. This article describes the Space Shuttle's main engine design and development, outlining requirements, obstacles, component testing, and engine testing. Discussing the *Challenger* tragedy and the Space Shuttle's return to flight, the author recounts NASA's efforts to attain full-power-level certification and acceptance tests for the Shuttle.
- Bizony, Piers. *The Space Shuttle: Celebrating Thirty Years of NASA's First Space Plane*. Minneapolis: Zenith Press–MBI Publishing, 2011. This illustrated book marks a special moment in history: STS-134, the final mission of Space Shuttle *Endeavour*. The author discusses the development and design of the Space Shuttle, its technical specifications, and the details of its major assemblies and subassemblies.
- Blomberg, Richard D. "Report on Shuttle Safety." *Ad Astra*, August 2002. This article summarizes the Space Shuttle safety issues addressed by NASA's Aerospace Safety Advisory Panel (ASAP), along with the panel's findings and recommendations regarding Space Shuttle plans and budgetary requests. The author also makes recommendations regarding ground infrastructure and launch workforce.
- Chien, Philip. "Shuttle Gets a Boost." *Popular Science*, August 1999. This article describes the avionics upgrade for Space Shuttle *Atlantis*.
- Corneille, Philip. "Refurbishing the Shuttle's SRBs." *Spaceflight*, August 2001. This article describes how Space Shuttle solid rocket boosters (SRBs) are made, launched, and recovered, as well as SRB refurbishment and reassembly. The author explains how SRBs are refurbished for use on later Shuttle missions.
- Covault, Craig. "Roaring Comeback." *Aviation Week & Space Technology*, 11 July 2005. This article discusses the Space Shuttle main engines (SSMEs) and solid rocket boosters (SRBs) that will propel *Discovery*'s launch into orbit in its return-to-flight mission. In the two years since the *Columbia* accident, NASA's SSME and SRB programs have substantially increased the rigor of their testing and quality oversight.
- Covault, Craig, and Frank Moring Jr. "Re-Discovery; As Discovery Roars Back to Space, Its Flight-Test Lessons Warn That the Program Still Needs Critical Work Back Here." *Aviation Week & Space Technology*, 1 August 2005. During STS-114 in 2005, *Discovery* sustained a low-speed bird strike at liftoff, which caused insulation to separate from the external tank and a piece of foam to come off the liquid hydrogen tank interface ring. The incidents reinforced the need for Marshall and Lockheed Martin to perform additional critical materials and manufacturing process work at its Michoud, Louisiana, tank assembly plant.

- Heppenheimer, T. A. *Development of the Space Shuttle, 1972–1981*. Vol. 2 of *History of the Space Shuttle*. The NASA History Series. Washington, DC: Smithsonian Books, 2010. This book focuses on the engineering challenges of building the Space Shuttle: the development of propulsion, thermal protection, electronics, and on-board systems. The author traces the Shuttle's development through the decade of engineering setbacks and breakthroughs, program-management challenges, and political strategizing that culminated in the first launch of the Space Shuttle in April 1981. He also discusses the planning and preparation for the first Shuttle launch.
- Hunley, J. D. *U.S. Space-Launch Vehicle Technology: Viking to Space Shuttle*. Gainesville, FL: University Press of Florida, 2008. This book examines hardware designed explicitly for launching vehicles into space and traces the evolution of that technology from the early Vanguard rocket program through the Space Shuttle. The author describes propulsion systems, structural issues, and guidance-and-control devices. He concludes that the major factors advancing the development of this technology included high levels of Cold War funding, an engineering culture that promoted technology transfer and was flexible enough to overcome unexpected problems, and management systems that furnished systems engineering and cost control over a huge number of organizations.
- Inside the Space Shuttle*. Videocassette (VHS). Port Washington, NY: Koch Vision, 1998. This video provides a behind-the-scenes glimpse into NASA's world of high technology, showing the most amazing flying machines humans have ever created—the Space Shuttles.
- Jenkins, Dennis R. *Space Shuttle: The History of Developing the National Space Transportation System, the Beginning Through STS-75*. Marceline, MO: Walsworth Publishing Company, 1997. This book discusses technical approaches to building an RLV or a semi-RLV. In addition, the author explains the history of the Space Shuttle, including its funding, construction, and flights. The book also describes the technology of the Space Shuttle, as it was originally built and as it has been modified through the years.
- Klesius, Michael. "The Evolution of the Space Shuttle." *Air & Space*, July 2010. In this article, the author discusses the history of the Space Shuttle program, explores modifications to the design of the Space Shuttle considered throughout the program, and examines the errors leading to the loss of *Challenger* in January 1986 and *Columbia* in February 2003.
- Lee, Wayne. *To Rise from Earth: An Easy-To-Understand Guide to Spaceflight*. 2nd ed. New York: Facts on File, 2000. The author explains the principles of rocket propulsion and discusses how the Space Shuttle achieves or changes orbit, describing the Shuttle's rockets and orbital mechanics. The book includes a chapter on space history, which traces the space milestones of the United States and Russia, and offers insight into the future of Mars exploration.
- Oberg, James. "Puncture Repair Kit; The Shuttle Columbia Might Have Been Saved If the Crew Had Been Able To Fix A Hole While in Orbit." *New Scientist*, 15 November 2003. This article examines NASA's efforts to create patch kits that astronauts could use to make

repairs to orbiters if they sustained damage such as *Columbia* experienced during its last takeoff. Besides trying out NASA's repair kit, the author identifies other options for inflight repairs to external surfaces of the spacecraft.

U.S. General Accounting Office. "Space Shuttle: Declining Budget and Tight Schedule Could Jeopardize Space Station Support." Report no. GAO/NSIAD-95-171, Washington, DC, 28 July 1995. <http://www.gao.gov/archive/1995/ns95171.pdf> (accessed 8 March 2012). This report reviews NASA's efforts to redesign the lift capability of the Space Shuttle so that it will be able to make the 21 flights necessary to complete the assembly of the ISS within five years. The GAO found that NASA's plans for increasing the Shuttle's lift capability are complex, involving approximately 30 individual actions, such as hardware redesigns, improved flight-design techniques, and new operational procedures.

U.S. General Accounting Office. "Space Shuttle: Status of Advanced Solid Rocket Motor Program." Report no. GAO/NSIAD-93-26, Washington, DC, November 1992. <http://archive.gao.gov/d36t11/148147.pdf> (accessed 8 March 2012). This report describes NASA's Advanced Solid Rocket Motor Program, which is intended to increase the lift capacity of the Space Shuttle. The GAO expresses concerns that the motor's actual price has far exceeded the estimate and that NASA may not need the solid rocket motor after all.

U.S. General Accounting Office. "Space Shuttle Main Engine: NASA Has Not Evaluated the Alternate Fuel Turbopump Costs and Benefits." Report no. GAO/NSIAD-94-54, Washington, DC, October 1993. <http://archive.gao.gov/t2pbat5/150179.pdf> (accessed 8 March 2012). This report focuses on NASA's decision to develop an alternative high-pressure fuel turbopump for the Space Shuttle's main engine. The report recommends that, before deciding whether to resume development of the alternate fuel pump, the NASA Administrator should require NASA officials to estimate the life-cycle costs and benefits for the alternative fuel-pump program and to compare them with the costs and benefits of further improvements to the existing pump.

Van de Haar, Gerard, and Luc van den Ableen. "KSC's Operations and Checkout Building." *Spaceflight*, July 1995. This article describes the building at NASA's Kennedy Space Center where NASA engineers prepare Space Shuttles for launch and inspect them after they return from a mission. The authors describe both the capabilities of the facility and the activities that take place inside it.

[Link to Part 1 \(1970–1991\), Chapter 4—Shuttle Design and Development](#)

[Link to Part 1 \(1970–1991\), Chapter 5—Space Shuttle Testing and Evaluation](#)

CHAPTER 5—OPERATIONS

Anselmo, Joseph C. “NASA To Seek Major Shift in U.S. Shuttle Policy.” *Aviation Week & Space Technology*, 13 October 1997. This article describes NASA’s support for United Space Alliance’s lobby to rescind an 11-year-old presidential edict and a provision in U.S. law prohibiting the Space Shuttle from carrying commercial satellites into orbit. United Space Alliance, the venture that manages Shuttle operations, is promoting these policy changes in the hope of completely privatizing Shuttle operations within five years. The expendable launch vehicle industry is likely to oppose the move so that it can retain its monopoly on commercial spacecraft launches.

Behar, Michael. “The Ground.” *Air & Space*, November 2006. The article focuses on the responsibilities of flight directors in space explorations. To be certified to work an actual launch and landing of a Space Shuttle, a flight director must undergo hundreds of Shuttle simulations and be prepared to overcome disaster scenarios.

Brandon-Cremer, Lee, and Joel Powell. *Space Shuttle Almanac*. Calgary, AB: Microgravity Productions, 1992. http://www.amazon.com/Space-Shuttle-Almanac-ebook/dp/B005IWAVOA/ref=sr_1_8?s=books&ie=UTF8&qid=1323720909&sr=1-8 (accessed 8 March 2012). In this final digital edition of the *Space Shuttle Almanac*, primary author Lee Brandon-Cremer celebrates 40 years of Shuttle operational history within a 1,400-page compilation of mission facts, figures, dates, and times. The almanac includes an outstanding collection of more than 1,000 photographs and more than 1,000 diagrams, covering every mission. The e-book is available on CD or by download.

Evans, Ben. *Space Shuttle Columbia: Her Missions and Crews*. Chichester, UK: Praxis Publishing, 2005. This book, written by the scientists and researchers who developed and supported *Columbia*’s many payloads, the engineers who worked on the spacecraft, and the astronauts who flew it, comprises detailed descriptions of Space Shuttle *Columbia*’s 28 missions. The book is intended as a tribute to *Columbia* and to the people who have supported the Shuttle program.

Green, Andrew. “STS-125: Hubble’s Final Refit in Orbit.” *Spaceflight*, August 2009. This article describes STS-125, Space Shuttle *Atlantis*’s mission to repair and upgrade the HST. The article describes prelaunch activities, crew members, and daily activities during the 12-day mission.

Hoversten, Paul. “The Truck: Satellites, Experiments, Space Station Parts—The Space Shuttle Hauled It All.” *Air & Space*, August 2010. In this article discussing Space Shuttle payloads and the work carried out on the Shuttle, the author details the numerous objects the Shuttle has carried into space, including the Magellan Venus probe in 1989, the Galileo Jupiter probe in 1989, the HST, and pieces of the ISS.

Kidger, Neville. “STS-119: Orbital Operations.” *Spaceflight*, May 2009. This article describes activities aboard the ISS, as well as summarizing STS-119, Space Shuttle *Discovery*’s

mission to deliver solar arrays to the ISS. The article lists the Shuttle crew members and describes the crew's activities during the 12-day mission.

Kidger, Neville. "STS-120: Orbital Operations." *Spaceflight*, January 2008. This article describes activities aboard the ISS, as well as summarizing STS-120, Space Shuttle *Discovery*'s mission to deliver Harmony Node, a connecting module that will increase the orbiting laboratory's interior space. STS-120 crew also repaired the ISS's solar arrays. The article lists the STS-120 crew members and describes day-to-day operations during the 16-day mission.

Kidger, Neville. "STS-122: Orbital Operations." *Spaceflight*, April 2008. This article describes activities aboard the ISS, as well as summarizing STS-122, Space Shuttle *Atlantis*'s mission to deliver and to install the Columbus laboratory, the ISS module contributed by ESA. The article lists STS-122 crew members and describes the crew's activities during the 13-day mission.

Kidger, Neville. "STS-123: Orbital Operations." *Spaceflight*, May 2008. This article describes activities aboard the ISS, as well as summarizing STS-123, Space Shuttle *Endeavour*'s mission to equip and supply the ISS. *Endeavour* delivered the Japanese Experiment Logistics Module, which contains avionics and will serve as a storage area for experiment materials. The article, which names STS-123 crew members and describes day-to-day operations during the 15-day mission, continues in the June 2008 edition of *Spaceflight*.

Kidger, Neville. "STS-123: Orbital Operations." *Spaceflight*, June 2008. This continues an article in the May 2008 edition of *Spaceflight* summarizing STS-123, Space Shuttle *Endeavour*'s mission to equip and supply the ISS. *Endeavour* delivered the Japanese Experiment Logistics Module, which contains avionics and will serve as a storage area for experiment materials. The article names STS-123 crew members and describes day-to-day operations during the 15-day mission.

Kidger, Neville. "STS-127: Orbital Operations." *Spaceflight*, October 2009. This article describes activities aboard the ISS, as well as summarizing STS-127, Space Shuttle *Endeavour*'s mission to deliver the Kibo Japanese Experiment Module Exposed Facility and Experiment Logistics Module Exposed Section. The article lists the Shuttle crew members and describes the crew's activities during the 15-day mission.

Kidger, Neville. "STS-128: Orbital Operations." *Spaceflight*, November 2009. This article describes activities aboard the ISS, as well as summarizing STS-128, Space Shuttle *Discovery*'s mission to deliver 7 tons (6.4 tonnes) of equipment and supplies to the ISS. After this mission, NASA will begin a transition from Shuttle missions to help build the ISS, to missions to use the ISS. The article lists crew members, recounts prelaunch activities, and describes activities during the 13-day mission.

Kremer, Ken. "STS-129: Shuttle Delivers Spares to ISS." *Spaceflight*, February 2010. This article describes STS-129, the mission of Space Shuttle *Atlantis* to equip and supply the ISS. The article lists crew members and daily activities during the 10-day mission.

- Kremer, Ken. "STS-130: New Window on the World." *Spaceflight*, April 2010. This article describes STS-130, Space Shuttle *Endeavour*'s mission to deliver equipment and supplies to the ISS. The article describes prelaunch activities, crew members, and activities during the 13-day mission.
- Kremer, Ken. "STS-131: Discovery's Penultimate Voyage." *Spaceflight*, June 2010. This article describes STS-131, in which Space Shuttle *Discovery* delivered 8 tons (7.3 tonnes) of equipment and supplies to the ISS. The article describes prelaunch activities, crew members, and day-to-day operations during the 15-day mission.
- Kremer, Ken. "STS-132: Atlantis' Last Blast with Russian Beauty." *Spaceflight*, August 2010. This article describes STS-132, Space Shuttle *Atlantis*'s final mission before its retirement. The goal of STS-132 was to equip and supply the ISS. Besides carrying spare parts to the ISS, *Atlantis* delivered the 11,000-pound (4,989.5-kilogram) Russian Rassvet Mini Research Module, which will enable ISS crew to conduct biotechnology and fluid physics experiments. The article describes prelaunch activities, crew members, payloads, and daily operations during the 11-day mission.
- Legler, Robert D., and Floyd V. Bennett. *Space Shuttle Missions Summary*. Hanover, MD: NASA Center for AeroSpace Information, September 2011. <http://www.scribd.com/doc/70899668/Space-Shuttle-Missions-Summary> (accessed 8 March 2012). This is a handy reference guide for data on all Space Shuttle missions. The book provides "as-flown" data for ascent, on-orbit events, and descent mission phases, compiled from many flight-support sources. In addition, the book identifies the specific Shuttle vehicle configuration, payload, flight crew, and flight directors for each flight and includes pertinent photos on each mission summary page.
- Marino, Joe. "Twenty Years of the Space Shuttle." *Ad Astra*, April 2001. This article presents photographs of Space Shuttle launches, including the liftoff of *Discovery*, STS-64, in September 1994.
- NASA. Johnson Space Center. "History of Space Shuttle Rendezvous." Report no. JSC-63400 Revision 3, Mission Operations Directorate, Flight Dynamics Division, Johnson Space Center, NASA, Houston, TX, October 2011. http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20110023479_2011024697.pdf (accessed 8 March 2012). This technical report provides an overview of rendezvous and proximity operations missions flown by the Space Shuttle from 1983 to 2011. Rendezvous profile evolution from 1969 to 2011 is covered, along with unique challenges faced by the Space Shuttle that were not encountered during the Gemini, Apollo, Skylab, and Apollo/Soyuz missions. Four chapters focus on the following: 1) STS-39 deploy/retrieve mission, 2) HST repair missions, 3) STS-130 mission to the ISS, and 4) the level of automation in U.S. spacecraft.
- Powell, Joel W., and Lee Robert Caldwell. *The Space Shuttle Almanac: A Comprehensive Overview of the First Ten Years of Space Shuttle Operations*. Calgary, Alberta: Microgravity Productions, 1992. This reference tool provides an overview of Space

Shuttle operations, facilities, hardware, and missions for the first 39 Shuttle flights. Using information from NASA publications, the authors describe the Shuttle orbiter, discuss each mission flown, and provide details on crew, experiments, and payloads.

Rumerman, Judith A., Chris Gamble, and Gabriel Okolski. "Space Shuttle." In *U.S. Human Spaceflight: A Record of Achievement, 1961–2006*, 35–74. Monographs in Aerospace History, no. 41. NASA Report no. SP-4541, NASA History Division, Office of External Relations, NASA Headquarters, Washington, DC, December 2007. <http://history.nasa.gov/monograph41.pdf> (accessed 8 March 2012). This chapter of NASA's book on human spaceflight describes Space Shuttle flights STS-1 through STS-116 (1981–2006) and provides information about each Shuttle mission, including crew-member names, Shuttle names, and the purpose of each mission. The chapter also provides a short bibliography on the Shuttle.

Rumerman, Judy A., and Stephen J. Garber. *Chronology of Space Shuttle Flights, 1981–2000*. NASA Report no. HHR-70, NASA History Division, Office of Policy and Plans, NASA Headquarters, Washington, DC, October 2000. This book, prepared by NASA's History Office, provides a chronology of Space Shuttle flights from 1981 through 2000.

Schuiling, Roelof. "STS-45 Mission Report." *Spaceflight*, October 1992. This article discusses STS-45, the mission of Space Shuttle *Atlantis* to carry the first Atmospheric Laboratory for Applications and Science (ATLAS-1) into orbit. ATLAS-1 was designed to conduct studies in atmospheric chemistry, solar radiation, space plasma physics, and ultraviolet astronomy. The author describes crew members, daily activities, launch preparation, and payloads during the nine-day mission.

Schuiling, Roelof. "STS-46 Mission Report." *Spaceflight*, January 1993. This article discusses STS-46, the mission of Space Shuttle *Atlantis* to deploy ESA's European Retrieval Carrier and to operate the joint project of NASA and Agenzia Spaziale Italiana (the Italian space agency)—the Tethered Satellite System. The author describes launch preparation, payloads, crew members, and activities during the eight-day mission.

Schuiling, Roelof. "STS-47 Mission Report." *Spaceflight*, April 1993. This article discusses STS-47, Space Shuttle *Endeavour*'s mission to carry Spacelab-J into orbit and to use it to conduct experiments in the Shuttle payload. A joint mission of NASA and Japan's space agency, NASDA, Spacelab-J uses an unpiloted Spacelab module to conduct microgravity investigations in materials and life sciences. The author describes launch preparation, payloads, crew members, and daily activities during the eight-day mission.

Schuiling, Roelof. "STS-49 Mission Report." *Spaceflight*, August 1993. This article discusses STS-49, Space Shuttle *Endeavour*'s mission to capture the INTELSAT-VI (F-3) satellite, which was stranded in an unusable orbit, and to install a new perigee kick motor on the satellite. The author describes crew members, daily activities, launch preparation, and payloads during the 11-day mission.

- Schuiling, Roelof. "STS-50 Mission Report." *Spaceflight*, November 1992. This article discusses STS-50, Space Shuttle *Columbia*'s mission to carry the United States Microgravity Laboratory 1 (USML-1), a piloted Spacelab module with a tunnel connecting to the crew compartment. USML-1 was designed to conduct containerless processing experiments, materials processing studies, and other experiments. The author describes crew members, daily activities, launch preparation, and payloads during the 14-day mission.
- Schuiling, Roelof. "STS-51 Mission Report." *Spaceflight*, December 1993. This article discusses STS-51, Space Shuttle *Discovery*'s mission to deploy the Advanced Communications Technology Satellite and the Orbiting and Retrievable Far and Extreme Ultraviolet Spectrograph-Shuttle Pallet Satellite. The author describes crew members, daily activities, launch preparation, and payloads during the 11-day mission.
- Schuiling, Roelof. "STS-52 Mission Report." *Spaceflight*, February 1993. This article discusses STS-52, Space Shuttle *Columbia*'s mission to deploy the Laser Geodynamic Satellite-2 and operate the U.S. Microgravity Payload-1. The author describes crew members, daily activities, launch preparation, and payloads during the 10-day mission.
- Schuiling, Roelof. "STS-53 Mission Report." *Spaceflight*, March 1993. This article discusses STS-53, Space Shuttle *Discovery*'s mission to deploy a classified DOD satellite and to conduct two unclassified secondary experiments in the Shuttle payload bay. The two secondary experiments were the Orbital Debris Radar Calibration Spheres and the Shuttle Glow Experiment/Cryogenic Heat Pipe Experiment. The author describes crew members, daily activities, launch preparation, and payloads during the eight-day mission.
- Schuiling, Roelof. "STS-54 Mission Report." *Spaceflight*, March 1993. This article discusses STS-54, Space Shuttle *Endeavour*'s mission to deploy the fifth Tracking and Data Relay Satellite (TDRS). A secondary mission was to carry into orbit the Hitchhiker Diffuse X-ray Spectrometer and conduct experiments with it in the Shuttle payload bay. The author describes crew members, daily activities, launch preparation, and payloads during the seven-day mission.
- Schuiling, Roelof. "STS-55 Mission Report." *Spaceflight*, July 1993. This article discusses STS-55, Space Shuttle *Columbia*'s mission to carry into orbit the reusable German Spacelab D-2 and to use it in the Shuttle's payload bay to conduct 88 experiments in astronomy, atmospheric physics, Earth observations, materials and life sciences, and technology applications. The author describes crew members, daily activities, launch preparation, and payloads during the 11-day mission.
- Schuiling, Roelof. "STS-56 Mission Report." *Spaceflight*, June 1993. This article discusses STS-56, Space Shuttle *Discovery*'s mission to carry Atmospheric Laboratory for Applications and Science-2 (ATLAS-2) into orbit and to use it to conduct experiments in the Shuttle payload bay. ATLAS-2 was designed to collect data on the relationship between the Sun's energy output and Earth's middle atmosphere. The author describes crew members, daily activities, launch preparation, and payloads during the 10-day mission.

- Schuiling, Roelof. "STS-57 Mission Report." *Spaceflight*, September 1993. This article discusses STS-57, Space Shuttle *Endeavour*'s mission to carry Spacehab into orbit and to use it to conduct biomedical and materials science experiments in the Shuttle payload bay. On this mission, Shuttle astronauts also conducted a spacewalk to retrieve the European Retrieval Carrier and stow it in the Shuttle's payload bay for return to Earth. The author describes crew members, daily activities, launch preparation, and payloads during the 11-day mission.
- Schuiling, Roelof. "STS-58 Mission Report." *Spaceflight*, January 1994. This article discusses STS-58, Space Shuttle *Columbia*'s mission to carry into orbit the second dedicated Spacelab for Life Sciences and to use it to conduct experiments in the Shuttle payload bay. Shuttle crew used Spacelab to conduct 14 experiments in cardiovascular and cardiopulmonary physiology, musculoskeletal physiology, neuroscience, and regulatory physiology. The author describes launch crew members, daily activities, launch preparation, and payloads during the 15-day mission.
- Schuiling, Roelof. "STS-59 Mission Report." *Spaceflight*, August 1994. This article discusses STS-59, Space Shuttle *Endeavour*'s mission to carry the Space Radar Laboratory (SRL) into orbit and to use it to conduct experiments in the Shuttle payload bay. The SRL, containing instruments such as the Spaceborne Imaging Radar-C, was designed to study Earth's ecosystem. The author describes crew members, daily activities, launch preparation, and payloads during the 12-day mission.
- Schuiling, Roelof. "STS-60 Mission Report." *Spaceflight*, April 1994. This article describes STS-60, the first mission of the U.S.-Russian Shuttle-*Mir* program and the first Space Shuttle flight of a Russian cosmonaut, Sergei K. Krikalev. STS-60 carried into orbit the commercially developed Spacehab laboratory module and used it to conduct experiments in the Shuttle payload bay. The author describes crew members, daily activities, launch preparation, and payloads during the nine-day mission.
- Schuiling, Roelof. "STS-62 Mission Report." *Spaceflight*, June 1994. This article discusses STS-62, Space Shuttle *Columbia*'s mission to carry into orbit NASA's U.S. Microgravity Payload 2 (USMP-2) and Office of Aeronautics and Space Technology 2 (OAST-2) and to use them to conduct experiments in the Shuttle payload bay. The author describes crew members, daily activities, launch preparation, and payloads during the 15-day mission.
- Schuiling, Roelof. "STS-63 Mission Report." *Spaceflight*, May 1995. This article discusses STS-63, the second mission of the U.S.-Russian Shuttle-*Mir* program. In STS-63, *Discovery* carried out the first rendezvous of a U.S. Space Shuttle with Russia's space station *Mir*. Known as the Near-*Mir* mission, STS-63 carried into orbit Spacehab 3 and the Space Radar Laboratory (SRL). STS-63 was the first flight in which a woman—astronaut Eileen M. Collins—piloted the Shuttle, and the second Shuttle flight carrying a Russian cosmonaut—Vladimir G. Titov. The author describes the nine-day mission's crew members, daily activities, launch preparation, and payloads.

- Schuiling, Roelof. "STS-64 Mission Report." *Spaceflight*, December 1994. The author of this article was Payload Manager of STS-64. In this article covering that mission, the author describes the preparation of Space Shuttle *Discovery* for launch and control room activities on launch day, focusing on the testing and preparation of STS-64's payloads, including the Lidar In Space Technology Experiment (LITE).
- Schuiling, Roelof. "STS-64 Mission Report: Laser Atmospheric Research, Robotic Operations, Untethered Spacewalk." *Spaceflight*, December 1994. This article discusses STS-64, Space Shuttle *Discovery*'s mission to conduct atmospheric research with a laser, use a robot to process semiconductor materials, and perform an untethered spacewalk. The author describes preflight processing, crew members, and Shuttle activities for each of the 12 days that the Shuttle was in space.
- Schuiling, Roelof. "STS-65 Mission Report." *Spaceflight*, October 1994. This article discusses STS-65, Space Shuttle *Columbia*'s mission to carry into orbit the second flight of the International Microgravity Laboratory 2 (IML-2). The author describes crew members, daily activities, launch preparation, and payloads during the 16-day mission.
- Schuiling, Roelof. "STS-66 Mission Report." *Spaceflight*, March 1995. This article discusses STS-66, the mission of Space Shuttle *Atlantis* to carry into orbit seven instruments on the Atmospheric Laboratory for Applications, as well as the Science-3 Cryogenic Infrared Spectrometers and Telescopes for the Atmosphere-Shuttle Pallet. The author describes crew members, daily activities, launch preparation, and payloads during the 12-day mission.
- Schuiling, Roelof. "STS-67 Mission Report." *Spaceflight*, July 1995. This article discusses STS-67, Space Shuttle *Endeavour*'s mission to carry into orbit the ASTRO Observatory and its three ultraviolet telescopes: the Hopkins Ultraviolet Telescope, the Wisconsin Ultraviolet Photo-Polarimeter Experiment, and the Ultraviolet Imaging. The author describes crew members, daily activities, launch preparation, and payloads during the 17-day mission.
- Schuiling, Roelof. "STS-68 Mission Report." *Spaceflight*, February 1995. This article discusses STS-68, Space Shuttle *Endeavour*'s mission to carry into orbit, for the second time, the Space Radar Laboratory (SRL) and to use it to conduct experiments in the Shuttle payload bay. The author describes STS-68 crew members, daily activities, launch preparation, and payloads during the 12-day mission.
- Schuiling, Roelof. "STS-69 Mission Report." *Spaceflight*, December 1995. This article discusses STS-69, Space Shuttle *Endeavour*'s mission to deploy and retrieve Spartan 201-03 and the Wake Shield Facility 2 (WSF-2), an experimental science platform. The author describes crew members, daily activities, launch preparation, and payloads during the 12-day mission.
- Schuiling, Roelof. "STS-70 Mission Report." *Spaceflight*, November 1995. This article discusses STS-70, Space Shuttle *Discovery*'s mission to deploy the Tracking and Data Relay

Satellite-G (TDRS-G) and to conduct experiments such as the Biological Research in Canister, which investigates the effects of spaceflight on small arthropod animal and plant specimens. The author describes crew members, daily activities, launch preparation, and payloads during the 10-day mission.

Schuiling, Roelof. “STS-71 Mission Report.” *Spaceflight*, October 1995. This article discusses STS-71, the mission of Space Shuttle *Atlantis* to dock with Russia’s space station *Mir* and to carry out joint on-orbit operations. This mission was the first time that a U.S. Space Shuttle had docked at *Mir*. The author describes crew members, daily activities, launch preparation, and payloads during the 11-day mission.

Schuiling, Roelof. “STS-72 Mission Report.” *Spaceflight*, April 1996. This article discusses STS-72, Space Shuttle *Endeavour*’s mission to retrieve the Japanese Space Flyer Unit satellite and to deploy and retrieve the Office of Aeronautics and Space Technology Flyer spacecraft. The author describes crew members, daily activities, launch preparation, and payloads during the 10-day mission.

Schuiling, Roelof. “STS-73 Mission Report.” *Spaceflight*, January 1996. This article discusses STS-73, Space Shuttle *Columbia*’s mission to carry the second United States Microgravity Laboratory (USML-2) into space for microgravity studies in the Shuttle payload. The author describes crew members, daily activities, launch preparation, and payloads during the 17-day mission.

Schuiling, Roelof. “STS-74 Mission Report.” *Spaceflight*, March 1996. This article discusses STS-74, the mission of Space Shuttle *Atlantis* to dock with Russia’s space station *Mir* for the second time and to transfer equipment and supplies to *Mir*. The author describes crew members, daily activities, launch preparation, and payloads during the nine-day mission.

Schuiling, Roelof. “STS-75 Mission Report.” *Spaceflight*, June 1996. This article discusses STS-75, Space Shuttle *Columbia*’s mission to deploy and retrieve the joint U.S.-Italian Tethered Satellite System. The crew had deployed the satellite and had begun gathering scientific data when the tether snapped on flight day three, as the satellite was just short of full deployment by about 12.8 miles. The author describes crew members, daily activities, launch preparation, and payloads during the 15-day mission.

Schuiling, Roelof. “STS-76 Mission Report.” *Spaceflight*, July 1996. This article discusses STS-76, the mission of Space Shuttle *Atlantis* to dock with Russia’s space station *Mir* for the third time and to deliver the first American female astronaut—Shannon W. Lucid—to live on *Mir*. The author describes crew members, daily activities, launch preparation, and payloads during the 10-day mission.

Schuiling, Roelof. “STS-77 Mission Report.” *Spaceflight*, August 1996. This article discusses STS-77, Space Shuttle *Endeavour*’s mission to carry into orbit the pressurized research module, Spacehab 4, and to use it to conduct experiments in agriculture, biotechnology, electronic materials, and polymers in the Shuttle payload bay. STS-77 crew also deployed

and retrieved the Spartan-207 free flyer. The author describes crew members, daily activities, launch preparation, and payloads during the 11-day mission.

Schuiling, Roelof. "STS-78 Mission Report." *Spaceflight*, October 1996. This article discusses STS-78, Space Shuttle *Columbia*'s mission to carry into space the Life and Microgravity Spacelab, to use it to conduct experiments in the Shuttle payload bay, and to study the effects of long-duration spaceflight on human physiology. The author describes crew members, daily activities, launch preparation, and payloads during the 18-day mission.

Schuiling, Roelof. "STS-79 Mission Report." *Spaceflight*, February 1997. This article discusses STS-79, the mission of Space Shuttle *Atlantis* to dock with Russia's space station *Mir* for the fourth time. The Shuttle brought the Spacehab Double Module to support Shuttle-*Mir* activities. The author describes crew members, daily activities, launch preparation, and payloads during the 11-day mission.

Schuiling, Roelof. "STS-80 Mission Report." *Spaceflight*, March 1997. This article discusses STS-80, Space Shuttle *Columbia*'s mission to deploy and retrieve the Orbiting and Retrievable Far and Extreme Ultraviolet Spectrometer-Shuttle Pallet Satellite 2 and the Wake Shield Facility 3 (WSF-3), an experimental science platform. The author describes crew members, daily activities, launch preparation, and payloads during the 18-day mission.

Schuiling, Roelof. "STS-81 Mission Report." *Spaceflight*, May 1997. This article discusses STS-81, the mission of Space Shuttle *Atlantis* to dock with Russia's space station *Mir* for the fifth time. The author describes crew members, daily activities, launch preparation, and payloads during the 18-day mission.

Schuiling, Roelof. "STS-82 Mission Report." *Spaceflight*, June 1997. This article discusses STS-82, Space Shuttle *Discovery*'s mission to service the HST. The author describes crew members, daily activities, launch preparation, and payloads during the nine-day mission.

Schuiling, Roelof. "STS-83 Mission Report." *Spaceflight*, October 1997. This article discusses STS-83, Space Shuttle *Columbia*'s mission to carry into orbit the Microgravity Science Laboratory 1 (MSL-1) and to use it to conduct 19 materials science investigations in the Shuttle payload bay. The mission was cut short because of concern over erratic readings from some Shuttle fuel cells. The author describes crew members, daily activities, launch preparation, and payloads during the four-day mission.

Schuiling, Roelof. "STS-84 Mission Report." *Spaceflight*, September 1997. This article discusses STS-84, the mission of Space Shuttle *Atlantis* to dock with Russia's space station *Mir* for the sixth time. The author describes crew members, daily activities, launch preparation, and payloads during the nine-day mission.

Schuiling, Roelof. "STS-85 Mission Report." *Spaceflight*, November 1997. This article discusses STS-85, Space Shuttle *Discovery*'s mission to deploy and retrieve the Cryogenic Infrared Spectrometers and Telescopes for the Atmosphere-Shuttle Pallet Satellite-2, as well as to

carry into space a number of payloads involving secondary experiments. The author describes crew members, daily activities, launch preparation, and payloads during the 11-day mission.

Schuiling, Roelof. "STS-86 Mission Report." *Spaceflight*, January 1998. This article discusses STS-86, the mission of Space Shuttle *Atlantis* to dock with Russia's space station *Mir* for the seventh time. The author describes crew members, daily activities, launch preparation, and payloads during the 10-day mission.

Schuiling, Roelof. "STS-87 Mission Report." *Spaceflight*, April 1998. This article discusses STS-87, Space Shuttle *Columbia*'s mission to conduct science experiments and to deploy and retrieve the SPARTAN-201-04 free-flyer, a Solar Physics Spacecraft. Experiments conducted in the Shuttle payload bay on the U.S. Microgravity Payload focused on combustion science, fundamental physics, and materials science. The author describes crew members, daily activities, launch preparation, and payloads during the 15-day mission.

Schuiling, Roelof. "STS-88: 'Unity' Module Delivered to Space Station." *Spaceflight*, March 1999. This article discusses STS-88, Space Shuttle *Endeavour*'s mission to begin construction of the ISS. The author describes crew members, daily activities, launch preparation, and payloads during the 13-day mission.

Schuiling, Roelof. "STS-89 Mission Report." *Spaceflight*, June 1998. This article discusses STS-89, Space Shuttle *Endeavour*'s mission to dock with the Russian space station *Mir* to deliver scientific equipment, logistical hardware, and water. The author describes crew members, daily activities, launch preparation, and payloads during the eight-day mission.

Schuiling, Roelof. "STS-90 Mission Report." *Spaceflight*, August 1998. This article discusses STS-90, Space Shuttle *Columbia*'s mission to study neuroscience. The *Columbia* payload included Neurolab and its 26 experiments related to the nervous system. The author describes crew members, daily activities, launch preparation, and payloads during the 15-day mission.

Schuiling, Roelof. "STS-91 Mission Report." *Spaceflight*, November 1998. This article discusses STS-91, Space Shuttle *Discovery*'s mission to dock with the Russian space station *Mir* and to deliver cargo, science experiments, and supplies. In addition, the crew moved long-term U.S. experiments that had been aboard *Mir* into *Discovery*'s mid-deck locker area. The author describes crew members, daily activities, launch preparation, and payloads during the nine-day mission.

Schuiling, Roelof. "STS-92: Discovery Completes 100th Shuttle Flight." *Spaceflight*, January 2001. This article describes STS-92, Space Shuttle *Discovery*'s mission to continue the construction of the ISS. The article describes launch preparation, payloads, crew members, and daily activities during the 14-day mission.

- Schuiling, Roelof. "STS-93: Launch Delays: Problems on Ascent." *Spaceflight*, December 1999. This article discusses STS-93, Space Shuttle *Columbia*'s mission to deploy the Chandra X-ray Observatory. STS-93 was the first mission in Space Shuttle history to be commanded by a woman—Eileen M. Collins. The author describes crew members, daily activities, launch preparation, and payloads during the six-day mission.
- Schuiling, Roelof. "STS-94 Mission Report." *Spaceflight*, October 1997. This article discusses STS-94, Space Shuttle *Columbia*'s repeat mission to carry into orbit the Microgravity Science Laboratory 1 (MSL-1) after erratic fuel cell readings shortened MSL-1's trip aboard STS-83. The author describes crew members, daily activities, launch preparation, and payloads during the 15-day mission.
- Schuiling, Roelof. "STS-95: 'The John Glenn Flight'." *Spaceflight*, February 1999. This article discusses STS-95, Space Shuttle *Discovery*'s mission to carry into orbit the pressurized Spacehab module and to use it to conduct a variety of scientific experiments in the Shuttle payload bay. On that mission, Shuttle crew members also deployed and retrieved the Spartan free-flyer payload, which gathered measurements of the solar corona and solar wind. Former Mercury program astronaut and U.S. Senator John H. Glenn Jr. was one of the STS-95 crew members, returning to space at the age of 77. The author describes the 10-day mission's crew members, daily activities, launch preparation, and payloads.
- Schuiling, Roelof. "STS-96: Discovery Shuttle Launched on First Mission of 1999." *Spaceflight*, October 1999. This article discusses STS-96, Space Shuttle *Discovery*'s mission to deliver parts and materials to the ISS. The author describes crew members, day-to-day operations, launch preparation, and payloads during the nine-day mission.
- Schuiling, Roelof. "STS-97: Endeavour Delivers Solar Arrays to ISS." *Spaceflight*, March 2001. This article discusses STS-97, Space Shuttle *Endeavour*'s mission to deliver solar arrays and supplies to the ISS. The author describes crew members, daily activities, launch preparation, and payloads during the 12-day mission.
- Schuiling, Roelof. "STS-98: Atlantis Carries Destiny to Orbit." *Spaceflight*, May 2001. This article describes STS-98, the mission of Space Shuttle *Atlantis* to take the United States' laboratory Destiny to the ISS. The article names the crew and describes their activities for each of the 14 days the Shuttle was in space.
- Schuiling, Roelof. "STS-99: Mapping the Earth's Surface by Radar." *Spaceflight*, May 2000. This article discusses STS-99, Space Shuttle *Endeavour*'s mission to map the Earth's surface using radar. The author describes the mission payload, which included the Shuttle Radar Topography Mission, the STS-99 crew, and the crew's activities on each of the 12 days that *Endeavour* was in space.
- Schuiling, Roelof. "STS-100: Endeavour Carries Robotic Components to ISS." *Spaceflight*, August 2001. This article discusses STS-100, Space Shuttle *Endeavour*'s mission to

equip and supply the ISS. The author describes crew members, daily activities, launch preparation, and payloads during the 13-day mission.

Schuiling, Roelof. "STS-101: Maintenance Mission to Unity-Zarya." *Spaceflight*, August 2000. This article discusses STS-101, the mission of Space Shuttle *Atlantis* to maintain the Unity and Zarya. Unity and Zarya were the first ISS components. The author describes crew members, daily activities, launch preparation, and payloads during the 11-day mission.

Schuiling, Roelof. "STS-102: Discovery Delivers Second Crew to Space Station." *Spaceflight*, June 2001. This article discusses STS-102, Space Shuttle *Discovery*'s mission to equip and supply the ISS. The author describes crew members, daily activities, launch preparation, and payloads during the 14-day mission.

Schuiling, Roelof. "STS-104: Atlantis Delivers Space Doorway to ISS." *Spaceflight*, October 2001. This article describes STS-104, the mission of Space Shuttle *Atlantis* to deliver and install a space doorway on the ISS. The article describes launch preparation, payloads, crew members, and activities during the 14-day mission.

Schuiling, Roelof. "STS-105: Space Shuttle Mission Report." *Spaceflight*, November 2001. This article discusses STS-105, Space Shuttle *Discovery*'s mission to equip and supply the ISS. The author describes crew members, daily activities, launch preparation, and payloads during the 13-day mission.

Schuiling, Roelof. "STS-106: Atlantis Revisits Space Station." *Spaceflight*, December 2000. This article describes STS-106, the mission of Space Shuttle *Atlantis* to equip the ISS and prepare the station for its first crew. The article describes launch preparation, payloads, crew members, and activities during the 13-day mission.

Schuiling, Roelof. "STS-107: Columbia's Final Mission." *Spaceflight*, April 2003. This article discusses Space Shuttle *Columbia*'s final mission, STS-107, describing launch preparation, payloads, crew members, and daily activities during the 15-day mission to conduct scientific experiments. *Columbia* and its crew were lost during reentry over east Texas on 1 February 2003, at about 9:00 a.m. (EST).

Schuiling, Roelof. "STS-108: Endeavour Carries Fourth Crew to Space Station." *Spaceflight*, March 2002. This article discusses STS-108, Space Shuttle *Endeavour*'s mission to equip and supply the ISS. The author describes crew members, daily activities, launch preparation, and payloads during the 13-day mission.

Schuiling, Roelof. "STS-111: Weather Delays Endeavour's Launch and Landing." *Spaceflight*, September 2002. This article discusses STS-111, Space Shuttle *Endeavour*'s mission to equip and supply the ISS. The author describes crew members, daily activities, launch preparation, and payloads during the 15-day mission.

- Schuiling, Roelof. "STS-112: Advances Space Station Assembly." *Spaceflight*, January 2003. This article describes STS-112, the mission of Space Shuttle *Atlantis* to deliver to the ISS the S1 integrated truss segment and spacewalk platform and to install the new components. The article describes launch preparation, payloads, crew members, and activities during the 12-day mission.
- Schuiling, Roelof. "STS-113: Endeavour Overcomes Technical Hitches To Deliver Sixth ISS Crew." *Spaceflight*, March 2003. This article discusses STS-113, Space Shuttle *Endeavour*'s mission to equip and supply the ISS. The author describes crew members, daily activities, launch preparation, and payloads during the 15-day mission.
- Shayler, David J. *Walking in Space*. New York: Springer-Praxis, 2004. This book provides a comprehensive overview and analysis of the techniques astronauts use in EVAs (spacewalks). The author draws on original documentation and on personal interviews with astronauts who have EVA experience, as well as on the accounts of staff involved in spacesuit design, EVA planning, and operations. The book describes the development of techniques for ensuring crew safety during spacewalks and looks ahead to future EVAs from the ISS and the development of new technology.
- Simpson, Clive. "STS-114: Return of the Space Shuttle." *Spaceflight*, October 2005. This article discusses STS-114, Space Shuttle *Discovery*'s mission to deliver equipment and supplies to the ISS. The author describes crew members, daily activities, launch preparation, and payloads during the 13-day mission.
- Simpson, Clive. "STS-115: Astronauts Complete Tough Mission." *Spaceflight*, November 2006. This article discusses STS-115, the mission of Space Shuttle *Atlantis* to deliver to the ISS the P3/P4 integrated truss and to install the truss and a pair of solar arrays on the ISS. The author describes crew members, daily activities, launch preparation, and payloads during the 11-day mission.
- Simpson, Clive. "STS-117: Atlantis Completes Spectacular Mission." *Spaceflight*, August 2007. This article discusses STS-117, the mission of Space Shuttle *Atlantis* to deliver to the ISS and to install the second and third starboard truss segments and an additional pair of solar arrays. The author describes crew members, daily activities, launch preparation, and payloads during the 17-day mission.
- Simpson, Clive, Gerard van der Haar, and Rudolf van Beest. "STS-116: Shuttle Mission Re-Wires ISS." *Spaceflight*, February 2007. This article discusses STS-116, Space Shuttle *Discovery*'s mission to deliver equipment and supplies to the ISS. The author describes crew members, daily activities, launch preparation, and payloads during the 12-day mission.
- Simpson, Clive, Gerard van der Haar, and Rudolf van Beest. "STS-118: Endeavour Finally Returns to Space." *Spaceflight*, October 2007. This article discusses STS-118, Space Shuttle *Endeavour*'s mission to deliver equipment and supplies to the ISS. The crew delivered and installed a third starboard truss segment and 5,000 pounds (2,268

kilograms) of equipment and supplies. The author describes crew members, daily activities, launch preparation, and payloads during the 12-day mission.

“The U.S. Space Shuttle: A Day in the Life.” *Ad Astra*, August 2002. This article presents photographs of the life cycle of a Space Shuttle mission.

U.S. Congress. Senate. Committee on Commerce, Science, and Transportation. Subcommittee on Science, Technology, and Space. *Results of Space Shuttle Endeavour Mission*. 102nd Cong., 2nd sess., 11 June 1992. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest Congressional). This hearing reviews the results of the 1992 Space Shuttle *Endeavour* flight, STS-49, specifically on-board research activities and the retrieval and reboost of a communications satellite.

Van de Haar, Rudolf. “STS-126: Mission Doubles Up Crew Capacity.” *Spaceflight*, February 2008. This article discusses STS-126, Space Shuttle *Endeavour*’s mission to deliver construction equipment to the ISS and to service the Solar Alpha Rotary Joints. The author describes crew members, daily activities, launch preparation, and payloads during the 15-day mission.

Van de Haar, Rudolf, Rudolf van Beest, and Clive Simpson. “STS-121: Back to Back for Discovery.” *Spaceflight*, September 2006. This article discusses STS-121, Space Shuttle *Discovery*’s mission to deliver equipment and supplies to the ISS and to demonstrate techniques for inspecting and protecting the Shuttle’s thermal protection system. The author describes crew members, daily activities, launch preparation, and payloads during the 12-day mission.

Wilson, Keith T. “From Landing . . . To Launch.” *Spaceflight*, October 1997. This article describes the short turnaround time (94 days) between Space Shuttle *Columbia*’s STS-83 and STS-94 missions, as well as the missions’ prelaunch processing. The staff of NASA’s Kennedy Space Center staff tested and evaluated the Shuttle for its return to space. The Microgravity Science Laboratory remained in the Shuttle between the two flights, the first time that a major payload had remained on-board while the Shuttle was on the ground.

Link to Part 1 (1970–1991), Chapter 6—Space Shuttle Operations

CHAPTER 6—CHALLENGER ACCIDENT AND AFTERMATH

- Adamson, Heather. *The Challenger Explosion*. Mankato, MN: Capstone Press, 2006. Ages 9–12. This graphic novel tells the story of Christa McAuliffe and the six other NASA astronauts who lost their lives in the Space Shuttle *Challenger* disaster on 28 January 1986.
- Arnett, Glenn. “Search for the *Challenger*.” *Air & Space*, May 1994. The article reports on the author’s participation in the search for Space Shuttle *Challenger*. The author describes difficulties in conducting the search, diving systems used in the search, the discovery of the main debris area, the discovery of *Challenger* crews’ remains, and how the search affected the author.
- Aviation Week Video. *Space Shuttle the Recovery*. Videocassette (VHS). New York: McGraw-Hill, 1992. This video focuses on the redesign and rebuilding of the Space Shuttle program at NASA to pinpoint exactly what went wrong with *Challenger* and how the problems were investigated and rectified.
- Biggs, R. E. *Space Shuttle Main Engine: The First Twenty Years and Beyond*. American Astronautical Society History Series, vol. 29. San Diego, CA: Univelt, 2008. This article describes the Space Shuttle’s main engine design and development, outlining requirements, obstacles, component testing, and engine testing. Discussing the *Challenger* tragedy and the Space Shuttle’s return to flight, the author recounts NASA’s efforts to attain full-power-level certification and acceptance tests for the Shuttle.
- Bredeson, Carmen. *The Challenger Disaster: Tragic Space Flight*. Berkeley Heights, NJ: Enslow Publishers, 1999. Ages 9–12. This book describes the events surrounding the explosion of Space Shuttle *Challenger* in 1986 and the investigation of the disaster, as well as the stories of the seven astronauts who died on the *Challenger*.
- Burgess, Colin. “Lost Mission.” *Spaceflight*, June 1999. This article describes how the loss of Space Shuttle *Challenger* in 1986 affected the future missions of Indonesian astronaut candidates for Space Shuttle missions. The U.S. government offered to train an Indonesian astronaut who would be a crew member on a mission to launch an Indonesian satellite. Post-tragedy launch delays forced NASA to launch the Indonesian satellite on an unmanned booster so the Indonesian astronaut candidates did not get to fly a Shuttle mission. The article also portrays the two astronaut candidates chosen to for the mission, Taufik Akbar and Pratiwi Sudarmono.
- Caper, William. *The Challenger Space Shuttle Explosion*. New York: Bearport, 2007. This book examines the events surrounding the explosion of Space Shuttle *Challenger* and discusses the significant changes to the Space Shuttle program that resulted from the loss of *Challenger*.
- Chiles, James R. “Out from the Shadow.” *Air & Space*, May 1996. This article profiles the Thiokol Corporation, the maker of the solid rockets that propel the Space Shuttle into

orbit. The author discusses the loss of Space Shuttle *Challenger* in 1986 and the role of the solid rocket in the *Challenger*'s explosion.

- Cole, Michael D. *Challenger: America's Space Tragedy*. Springfield, NJ: Enslow Publishers, 1995. Ages 9–12. Grades 4–6. The author clearly describes the Space Shuttle's technical problems, turning each mission into a tense tale of danger, courage, and obstacles overcome or—in *Challenger*'s case—deliberately ignored. The book, which includes the biographies of the people involved with *Challenger*, includes many small photos.
- Evans, Ben. *Space Shuttle Challenger: Ten Journeys into the Unknown*. Chichester, UK: Praxis Publishing, 2007. This book details the design, development, and construction of Space Shuttle *Challenger*. There are stories of *Challenger*'s missions from the points of view of the astronauts, engineers, scientists who flew and knew the Shuttle, and the managers, technicians, and ground personnel who worked on *Challenger* and made the spacecraft into one of the most capable Shuttles in NASA's service. *Challenger* veterans, including C. Gordon Fullerton and Vance D. Brand, describe their experiences and the differences between *Challenger* and the other Shuttles.
- Fahey, Kathleen. *Challenger and Columbia*. Milwaukee, WI: Gareth Stevens Publishing, 2005. Ages 9 and older. The book describes the events leading up to the loss of Space Shuttles *Challenger* and *Columbia*. Based on detailed descriptions, expert testimony, and firsthand accounts, the author takes an in-depth look at the *Challenger* and *Columbia* tragedies and discusses the lessons learned from them.
- Hall, Joseph Lorenzo. "Columbia and Challenger: Organizational Failure at NASA." *Space Policy* 19, no. 4 (November 2003): 237–247. This article outlines some of the critical features of NASA's organization. The author discusses organizational change at NASA, namely "path dependence" and "normalization of deviance." He reviews the reasons that experts have called the *Challenger* tragedy an organizational failure. Finally, he argues that the recent *Columbia* accident also displays characteristics of organizational failure and proposes recommendations for the future.
- Heimann, C. F. Larry. "Understanding the Challenger Disaster: Organizational Structure and the Design of Reliable Systems." *American Political Science Review* 87, no. 2 (June 1993): 421–435. This article describes the loss of Space Shuttle *Challenger* and assesses the effect that the disaster had on NASA's organizational ability and behavior. The author presents a theory of organizational reliability before and after the incident.
- Holden, Henry M. *The Tragedy of the Space Shuttle Challenger*. Berkeley Heights, NJ: MyReportLinks.com Books, 2004. Ages 9–12. This book describes events surrounding the explosion of Space Shuttle *Challenger* in 1986 and discusses the investigation of this disaster. The author tells the stories of the seven astronauts who died. The book also includes Internet links to related Web sites, source documents, and photographs.
- Kortenkamp, Steve. *Space Shuttles*. Mankato, MN: Capstone Press, 2008. Ages 4–8. This book describes the history and uses of NASA's Space Shuttles, including both the practical

uses and the drawbacks of reusable Space Shuttles. The author explains how the Shuttle flies and how it launches satellites. In addition, he describes how astronauts travel into space to make repairs on missions such as that to service the HST. The book also includes information about the two Shuttle disasters.

- Lieurance, Suzanne. *The Space Shuttle Challenger Disaster in American History*. Berkeley Heights, NJ: Enslow Publishers, 2001. Ages 9–12. Grades 5–7. After recounting the events of the morning that Space Shuttle *Challenger* exploded, the author places the *Challenger*'s mission in historical context. She summarizes the U.S. space program up to that time, profiles each of the astronauts assigned to the *Challenger* crew, and discusses the selection and training of civilian teacher Christa McAuliffe for the mission.
- Maier, Mark. "Ten Years After a Major Malfunction . . . : Reflections on 'The *Challenger* Syndrome'." *Journal of Management Inquiry* 11, no. 3 (September 2002): 282–292. This article reviews the insights gleaned from the *Challenger* disaster case study. Little known facts about the case are revealed, including serious questions about the veracity of the Rogers Commission report, which investigated the accident. Seven key elements of "the *Challenger* syndrome" are presented, pinpointing existing bureaucratic imperatives as a primary obstacle to the exercise of leadership and ethical decision making. The article closes with 10 central leadership lessons from the *Challenger* case study.
- Martin, Ryan M, and Louis A. Boynton. "From Liftoff to Landing: NASA's Crisis Communications and Resulting Media Coverage Following the Challenger and Columbia Tragedies." *Public Relations Review* 31, no. 2 (June 2005): 253–261. NASA's public relations effort following the explosion of *Challenger* in 1986 is considered an example of crisis communications failure. However, after the *Columbia* disaster in 2003, NASA was praised for its successful handling of the crisis. Using widely accepted crisis communication concepts associated with stakeholder theory, the author discusses how four newspapers presented NASA's crisis communication efforts following the two crises, showing that the print media accorded NASA more positive coverage following the *Columbia* disaster than the *Challenger* disaster.
- McDonald, Allan J., and James R. Hansen. *Truth, Lies, and O-Rings: Inside the Space Shuttle Challenger Disaster*. Gainesville, FL: University Press of Florida, 2009. The authors are an engineer and executive of Morton Thiokol, the maker of the Shuttle's solid rocket booster, and aerospace historian James R. Hansen. The book draws attention to the factors that led to the accident, some of which were never included in NASA's Failure Team report submitted to the Presidential Commission. It also addresses the early warnings of very severe debris issues from the first two post-*Challenger* flights.
- McNeese, Tim. *The Challenger Disaster*. New York: Children's Press, 2003. This book documenting the *Challenger* disaster chronicles the failures on the part of NASA engineers to prevent the tragic accident and provides information about the mission and its crew members.

- Morring, Frank, Jr. "Risk Analyses; Academies Panel Urges NASA To Use Shuttle Instead of Robot for Hubble Servicing." *Aviation Week & Space Technology*, 13 December 2004. The author of this article urges NASA to send a Space Shuttle mission to service the HST, arguing that it is too valuable to risk sending a robotic mission to extend the Hubble's life. In the wake of the *Challenger* and *Columbia* disasters, NASA Administrator Sean O'Keefe had cancelled the planned Shuttle mission to the Hubble out of concern for the potential risk to the Shuttle crew, but a panel of experts finds that recent safety upgrades to the Shuttle have made the risk of a mission to the HST only marginally greater than the planned missions to the ISS.
- Pike, John. "But What Is the True Rationale of Human Spaceflight?" *Space Policy* 10, no. 3 (August 1994): 217–222. The author states that the U.S. space program was adrift after the *Challenger* accident. He then focuses on the need for human spaceflight and its contribution to Space Shuttle projects that would benefit society.
- Powell, Joel W. "A Cold Day at the Kennedy Space Center." *Spaceflight*, February 2006. This article marks the twentieth anniversary of the *Challenger* disaster, which occurred on 28 January 1986. The author describes liftoff preparations for the days leading up to the launch. It would take 32 months before NASA would resume Shuttle flights after the *Challenger* disaster.
- Shayler, David. *Disasters and Accidents in Manned Spaceflight*. London: Springer, 2000. This book provides a superb overview of the history of human spaceflight accidents to the date of its publication. After explaining the challenges and dangers of launch, flight, and landing, the author discusses and evaluates each major spaceflight accident, as well as lesser known near accidents. The loss of *Columbia* had not yet occurred when the book was published.
- Spangenburg, Ray, Diane Moser, and Kit Moser. *Onboard the Space Shuttle*. New York: Franklin Watts, 2002. Grades 5–9. The authors explain what life in space is like and describe the oddities that an aspiring astronaut must expect. Sections of the book cover the significant accomplishments of landmark Space Shuttle missions, such as the mission to repair the HST, as well as space stations and the *Challenger* explosion. The book also features many interesting color photographs and sidebars providing statistics, information about individual astronauts, and scientific principles related to space travel.
- Streissguth, Thomas. *The Challenger: The Explosion on Liftoff*. Mankato, MN: Capstone High-Interest Books, 2003. Ages 9–12. This book examines Space Shuttle *Challenger* and the events that led to its destruction, along with the effects of the disaster on NASA's space program.
- Tompkins, Phillip K. *Apollo, Challenger, Columbia: The Decline of the Space Program: A Study in Organizational Communication*. New York: Oxford University Press, 2004. This book portrays NASA from 1958 to 2003, concentrating on several specific points in the history of the space program, including 1986 and 2003, the periods surrounding the two Space Shuttle disasters. The author investigates the internal communication failures that

resulted in the 1986 explosion of *Challenger* and the catastrophic failure of *Columbia* in 2003.

U.S. General Accounting Office. “Space Shuttle: Need To Sustain Launch Risk Assessment Process Improvements.” Report no. GAO/NSIAD-96-73, Washington, DC, March 1996. <http://www.gao.gov/archive/1996/ns96073.pdf> (accessed 8 March 2012). This report reviews NASA’s actions to improve the flow of information in launch decisions following the *Challenger* explosion. The GAO found that NASA has successfully created numerous formal and informal communication channels and an open organizational culture that encourages people to discuss safety concerns and to elevate unaddressed concerns to higher management levels.

Vaughan, Diane. *The Challenger Launch Decision: Risky Technology, Culture, and Deviance at NASA*. Chicago: University of Chicago Press, 1996. The author recreates the steps leading up to the fateful decision to launch *Challenger*, contradicting conventional interpretations to prove that what occurred at NASA was not misconduct but a disastrous mistake. She reveals how and why NASA insiders, when repeatedly faced with evidence that something was wrong, normalized the deviance so that it became acceptable to them.

White, Thomas Gordon, Jr. “The Establishment of Blame as a Framework for Sensemaking in the Space Policy Subsystem: A Study of the Apollo 1 and Challenger Accidents—Open Thesis.” PhD Dissertation, Virginia Polytechnic Institute and State University, Blacksburg, VA, April 2000. <http://www.openthesis.org/documents/Establishment-Blame-As-Framework-Sensemaking-582553.html> (accessed 8 March 2012). This dissertation investigates how the establishment of blame becomes a framework for a national policy subsystem to make sense of a tragic event. Using the Apollo 1 and Space Shuttle *Challenger* accidents as case studies, the author examines the space policy subsystem’s response to these two accidents and the process of establishing culpability.

[Link to Part 1 \(1970–1991\), Chapter 7—Challenger Accident and Aftermath](#)

CHAPTER 7—THE SPACE SHUTTLE AND THE HUBBLE SPACE TELESCOPE

“A Black Hole in the Sky.” *Economist*, 14 November 1998. NASA is upgrading the Space Shuttle fleet to enable the Shuttles to carry parts needed to build the ISS, thereby reducing the space station’s dependence on unpiloted Russian supply ships for refueling. NASA may delay essential repairs to the HST so that it can send additional Shuttle flights to help build the ISS.

Achenbach, Joel. “Hubble Mission Opens Shuttle’s Last Act; Aging, Flawed Space Vehicle Still Has Its Fans.” *Washington Post*, 12 May 2009. As the end of the Space Shuttle program draws near, this article discusses its use in supporting the HST.

Covault, Craig. “Hubble Mission Scrambles To Make Surprise Repairs.” *Aviation Week & Space Technology*, 24 February 1997. This article describes EVAs (spacewalks) that the Space Shuttle crew performed during STS-82 to repair the HST and explains how the crew overcame major unexpected events that occurred during that mission.

Cowen, Ron. “End of the Line for Hubble?” *Science News*, July 24, 2004. Citing safety concerns that came to light after the Space Shuttle *Columbia* tragedy in February 2003, NASA Administrator Sean O’Keefe announced that NASA was not going to send any more Shuttle missions to upgrade or repair the HST. Rather than sending astronauts, NASA proposes to send a robotic mission to repair and upgrade the orbiting observatory.

DiChristina, Mariette. “Fixing Hubble.” *Popular Science*, December 1993. This article focuses on NASA’s 11-day mission, STS-61, to repair the troubled HST.

“Double, Double, Hubble Trouble.” *Economist*, 27 November 1999. This article discusses the various problems that NASA encountered during the second half of 1999, including the shutdown of the HST, as the result of gyroscope failures, and the grounding of NASA Space Shuttles following problems with *Columbia*. The article also reports that NASA has scheduled Space Shuttle *Discovery* for a 10-day mission to fix the HST.

Green, Andrew. “STS-125: Hubble’s Final Refit in Orbit.” *Spaceflight*, August 2009. This article describes STS-125, Space Shuttle *Atlantis*’s mission to repair and upgrade the HST. The article describes prelaunch activities, crew members, and daily activities during the 12-day mission.

Gugliotta, Guy. “Use Shuttle To Fix Hubble, NASA Is Told; Risks to Astronauts Acceptable, Panel Says.” *Washington Post*, 9 December 2004. A congressionally mandated committee of the National Research Council (NRC) delivered to NASA’s leadership a report concluding that NASA would be able to use the Space Shuttle to service the HST without posing unacceptable risks to the astronauts.

“Hubble Repair Mission: STS-61.” *Spaceflight*, January 1994. This short article describes STS-61, Space Shuttle *Endeavour*’s successful mission to repair the HST. The article gives a daily list of activities of the *Endeavour* crew.

- Jenkins, Dennis R., and Jorge R. Frank. *Servicing the Hubble Space Telescope: Space Shuttle Atlantis—2009*. North Branch, MN: Specialty Press, 2009. This book describes STS-125, the Space Shuttle mission to service the HST for one last visit before the Shuttle fleet retires. Over 12 days and five spacewalks, the crew of Space Shuttle *Atlantis* made repairs and upgrades to the telescope, leaving it in better shape than ever and ready for another five years or more of research.
- Macilwain, Colin. “Hubble Stakes Are High for NASA’s Future.” *Nature* 366, no. 6453 (25 November 1993): 290. This article describes a planned high-stakes Space Shuttle mission to repair the HST and discusses NASA’s battle against budget cuts.
- Morring, Frank, Jr. “A Power Play 315 Miles High.” *Aviation Week & Space Technology*, 11 March 2002. In a difficult service mission, the crew from Space Shuttle *Columbia* upgraded instruments and installed two new solar arrays on the HST. The solar arrays will generate more power, while reducing atmospheric drag.
- Morring, Frank, Jr. “One More Time; Hubble Program Planning Final Shuttle Mission as Early as 2007 To Maintain the Observatory.” *Aviation Week & Space Technology*, 11 July 2005. This article describes NASA’s decision to approve a Shuttle mission to repair the HST. The author also discusses NASA’s efforts to schedule a realistic number of Shuttle flights to enable the ISS partners to complete assembly of the space station before the Shuttle’s planned retirement at the end of 2010.
- Morring, Frank, Jr. “Risk Analyses; Academies Panel Urges NASA To Use Shuttle Instead of Robot for Hubble Servicing.” *Aviation Week & Space Technology*, 13 December 2004. The author of this article urges NASA to send a Space Shuttle mission to service the HST, arguing that it is too valuable to risk sending a robotic mission to extend the HST’s life. In the wake of the *Challenger* and *Columbia* disasters, NASA Administrator Sean O’Keefe had cancelled the planned Shuttle mission to the HST out of concern for the potential risk to the Shuttle crew. However, a congressionally mandated committee of the National Research Council (NRC) has found that recent safety upgrades to the Shuttle have made the risk of a mission to the HST only marginally greater than the risks involved in the planned missions to the ISS.
- Morring, Frank, Jr., and Jefferson Morris. “Paradigm Shift; Hubble Repair Mission Recast for a New Age of Exploration.” *Aviation Week & Space Technology*, 6 November 2006. This article describes NASA’s preparations for a Space Shuttle mission to service the HST.
- Morgan, Daniel. “Hubble Space Telescope: NASA’s Plans for a Servicing Mission.” CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 23 May 2008. <http://digital.library.unt.edu/ark:/67531/metacrs10603/> (accessed 8 March 2012). This report describes the background for NASA’s decision to service the HST with a mission to replace key telescope components. Without the mission, the HST would cease scientific operations in 2008.

- National Research Council. *Assessment of Options for Extending the Life of the Hubble Space Telescope; Final Report*. Washington, DC: The National Academies Press, 2005. http://www.nap.edu/openbook.php?record_id=11169&page=R1 (accessed 10 April 2012). In this report, the Committee on the Assessment of Options for Extending the Life of the Hubble Space Telescope assesses the scientific value of continued HST operation, the safety issues of using the Space Shuttle and a crew of astronauts to service the HST, the feasibility of robotic servicing, the risks and benefits of acceptable servicing options, and the effects of these servicing options on the HST's science capability.
- Pickrell, J. "Telescope Tuned Up." *Science News*, 16 March 2002. This article describes how the crew of Space Shuttle *Columbia* renovated the HST on 9 March 2002. Over five days, four STS-109 astronauts performed 36 hours of spacewalks from *Columbia* to replace worn components of the HST and to install new devices.
- Schuiling, Roelof. "STS-61 Mission Report." *Spaceflight*, March 1994. This article describes STS-61, Space Shuttle *Columbia*'s first mission to service and add new solar arrays to the HST. The article describes launch preparation for the mission, payloads, crew members, and daily activities during the 12-day mission.
- Schuiling, Roelof. "STS-82 Mission Report." *Spaceflight*, June 1997. This article discusses STS-82, Space Shuttle *Discovery*'s mission to service the HST. The author describes crew members, daily activities, launch preparation, and payloads during the nine-day mission.
- Schuiling, Roelof. "STS-103: Three EVAs Fix Hubble." *Spaceflight*, March 2000. This article describes STS-103, Space Shuttle *Discovery*'s mission to service and repair the HST. The article describes launch preparation, payloads, crew members, and daily activities during the nine-day mission.
- Schuiling, Roelof. "STS-109: Columbia Mission Upgrades Hubble." *Spaceflight*, June 2002. This article describes STS-109, Space Shuttle *Columbia*'s mission to service the HST. The article describes launch preparation, payloads, crew members, and daily activities during the 12-day mission.
- Spangenburg, Ray, Diane Moser, and Kit Moser. *Onboard the Space Shuttle*. New York: Franklin Watts, 2002. Grades 5–9. The authors explain what life in space is like and describe the oddities that an aspiring astronaut must expect. Sections of the book cover the significant accomplishments of landmark Space Shuttle missions, such as the missions to repair the HST, as well as space stations and the *Challenger* explosion. The book also features many interesting color photographs and sidebars providing statistics, information about individual astronauts, and scientific principles related to space travel.
- U.S. Congress. House of Representatives. Committee on Science and Technology. *NASA's Space Shuttle and International Space Station Programs: Status and Issues*. 110th Cong., 1st sess., 24 July 2007. <http://www.gpo.gov/fdsys/pkg/CHRG-110hhr36737/html/CHRG-110hhr36737.htm> (accessed 8 March 2012). This hearing examines the main challenges to NASA accomplishing its major goals—to continue successfully flying the Space

Shuttle until its planned retirement in 2010 and to complete a planned Shuttle mission to service the HST. The hearing also considers the obstacles to completing the assembly of the ISS by the time NASA retires the Space Shuttle.

U.S. Congress. Senate. Committee on Appropriations. Subcommittee on Veterans Affairs, Housing and Urban Development, and Independent Agencies. *Hubble Space Telescope: Special Hearing*. 103rd Cong., 2nd sess., 8 February 1994. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest Congressional). This hearing reviews NASA's 1994 Space Shuttle mission STS-61 to repair the HST.

U.S. Government Accountability Office. "Space Shuttle: Costs for Hubble Servicing Mission and Implementation of Safety Recommendations Not Yet Definitive." Report no. GAO-05-34, Washington, DC, November 2004. <http://www.gao.gov/new.items/d0534.pdf> (accessed 8 March 2012). This report reviews NASA's decision to cancel the final planned HST servicing mission, a decision that prompted debate about potential alternatives to prolonging Hubble's mission. The GAO addresses the basis of NASA's cost estimates to service the HST using the Space Shuttle and to implement recommendations made by the *Columbia* Accident Investigation Board (CAIB).

Zubrin, Robert. "Ditching Hubble Bodes Poorly for Future Space Exploration." *Ad Astra*, June 2004. This article presents information on the decision of NASA Administrator Sean O'Keefe to halt all support missions to the HST on 16 January 2004. The article also notes HST's discoveries, the costs of the HST support missions, and descriptions of the risks involved with Shuttle flights.

Link to Part 1 (1970–1991), Chapter 9—Science on the Shuttle, Potential and Actual

CHAPTER 8—SCIENCE ON THE SPACE SHUTTLE

- Burgess, Colin, and Chris Dubbs. *Animals in Space: From Research Rockets to the Space Shuttle*. New York: Springer, 2007. This book is a detailed account of the history of animal spaceflights carried out by the U.S.S.R., United States, and other nations. The book describes how animal high-altitude and spaceflight research affected spaceflight biomedicine and technology and helped human beings undertake spaceflight with greater understanding and confidence.
- Covault, Craig. “Unusual Shuttle Operations Advance Commercialization.” *Aviation Week & Space Technology*, 2 December 1996. This article describes STS-80 and the difficulty the *Columbia* crew had in releasing the 2-ton (1.8-tonne) commercial Wake Shield Facility (WSF), an experimental science platform, from the Shuttle payload. The WSF, used to produce wafer semiconductors in space, is an example of the Space Shuttle’s commercial utility.
- Davidson, Arthur F. “Far-Ultraviolet Astronomy on the Astro-1 Space Shuttle Mission.” *Science* 259, no. 5093 (15 January 1993): 327. This article examines early results from the Hopkins Ultraviolet Telescope, observations obtained on the Astro-1 mission, STS-35, launched on 2 December 1990 and landed on 10 December 1990, of Space Shuttle *Columbia*.
- Evans, Ben. “STS-70 Preview.” *Spaceflight*, May 1995. This article previews STS-70, Space Shuttle *Discovery*’s mission to deliver the Tracking and Data Relay Satellite (TDRS) and to conduct research with the Inter-Mars Tissue Equivalent Proportional Counter. The article describes the crew members and secondary payload experiments of STS-70.
- Heusel, Catherine. “Medicine from Space; NASA’s Efforts To Probe the Heavens Have Produced Down to Earth Medical Advances That Keep Fetuses Alive, Provide Early Diagnosis of Cancer, and Offer Hope for Treating Osteoporosis.” *Washington Post*, 10 August 1999. Among more than a dozen scientific experiments, Space Shuttle *Columbia* crew carried out two medical tests to determine whether certain drugs might protect future space voyagers from the bone and muscle degeneration caused by weightlessness. These tests are part of NASA’s long-term medical mission to monitor and treat people who are hundreds, thousands and, potentially, millions of miles away from the nearest hospital.
- Kremer, Ken. “STS-132: Atlantis’ Last Blast with Russian Beauty.” *Spaceflight*, August 2010. This article describes STS-132, Space Shuttle *Atlantis*’s final mission before its retirement. The goal of STS-132 was to equip and supply the ISS. Besides carrying spare parts to the ISS, *Atlantis* delivered the 11,000-pound (4,989.5-kilogram) Russian Rassvet Mini Research Module, which will enable ISS crew to conduct biotechnology and fluid physics experiments. The article describes prelaunch activities, crew members, payloads, and daily operations during the 11-day mission.

- Lawler, Andrew. "How Much Space for Science." *Science* 303, no. 5658 (30 December 2004): 610–612. The article describes a U.S. National Academy of Science conference for scientists and engineers who gathered to offer advice regarding the country's human spaceflight program. The article describes the struggle between those scientists and engineers who prefer human spaceflight, using the Space Shuttle and other space vehicles, and those who prefer uncrewed spaceflight.
- Lawler, Andrew. "NASA May Cut Shuttle Flights and Reduce Science on Station." *Science* 309, no. 5734 (22 July 2005): 540–541. This article focuses on NASA's plan to curtail Space Shuttle flights and to reduce science research activities on the ISS.
- Lawler, Andrew. "Will NASA Annihilate Station Antimatter Experiment?" *Science* 303, no. 5664 (12 March 2004): 1590–1591. This article indicates NASA is reconsidering its support for an innovative experiment that is designed to capture direct evidence of elusive antimatter. The Alpha Magnetic Spectrometer is designed to detect antimatter, which scientists believe makes up half of the universe but has never been found.
- Lawler, Andrew, Daniel Clery, and Dennis Normile. "Life Science Research on Space Station Is Headed for Big Cuts." *Science* 308, no. 5722 (29 April 2005): 610–611. The authors report that NASA is finalizing a new plan to reduce the quality and quantity of cutting-edge research on the ISS. The cost of returning the Space Shuttle to flight, finishing the ISS by 2010, and building new launchers will have a negative effect on continuing high-priority research in biology at the space station.
- Leary, Warren E. "Newts and Metal Projects Ride Columbia into Space." *New York Times*, 9 July 1994. Space Shuttle *Columbia* carried a crew of seven into space today for a two-week mission, STS-65, to study both the subtle and the grand effects of gravity on materials and living things. The experiments involve work with exotic furnaces that can produce unusual alloys and with a rotating centrifuge that can simulate different levels of gravity. The equipment also includes aquariums teeming with thousands of animals, including goldfish, killifish, jellyfish, sea urchins, and Japanese red-bellied newts.
- Leary, Warren E. "Shuttle Soars into Space on Mission To Detect Environmental Changes on Earth." *New York Times*, 1 October 1994. During STS-68, Space Shuttle *Endeavour* began sweeping Earth with advanced radars in an effort to detect and monitor both natural and human-induced environmental changes that affect life on the planet. In addition to studying global change, the radars are to be used to examine the habitat of endangered pandas in China, to inspect the area around the Chernobyl nuclear power plant in Ukraine to see how the environment has recovered from the 1986 nuclear accident, and to scan stagnant water pools in areas of malaria outbreaks to see which might best support disease-carrying mosquito populations.
- Leath, Kevin. "Shaping Up for the Final Frontier." *Ad Astra*, June 1993. This article outlines the life sciences research requirements and the needed ground-based or in-space platforms of supporting human space exploration. Crew health and life-friendly spacecraft environments are also described.

- Lenorovitz, Jeffrey M. "Steady Growth Seen for Commercial Space." *Aviation Week & Space Technology*, 15 March 1993. In this article, the author argues that Space Shuttles will fly missions that include more science experiments. *Endeavour* has been fitted with Spacehab, a pressurized laboratory that provides additional locker volume, as well as working and living areas for astronauts and experiments. Spacehab will enable more materials processing and other production work in microgravity.
- McElroy, John H. "Some Thoughts on Space Station Science." *Space Policy* 17, no. 4 (November 2001): 257–260. The author comments that ISS budget cuts negatively affect U.S. scientific capabilities and undermine the United States' investment in the Space Shuttle.
- National Research Council. Committee on an Assessment of Balance in NASA's Science Programs. *An Assessment of Balance in NASA's Science Programs*. Washington DC: National Academies Press, 2006. In this report, the National Research Council (NRC) assesses the health of NASA's support for its established scientific disciplines, under the budget requests imposed by the space exploration initiative. The report also analyzes NASA's science budget to determine whether it reflects cross-disciplinary scientific priorities appropriately.
- Pletser, Vladimir. "ESA's Fluid Physics Experiments on STS-78." *Spaceflight*, October 1996. This article describes the fluid physics experiments that ESA conducted aboard *Columbia* during STS-78 in 1996.
- Schuiling, Roelof. "Loads of Payloads!" *Spaceflight*, August 1996. This article describes payloads aboard Space Shuttle *Endeavour* STS-77 in 1996. The article gives short descriptions of the many experiments on Spacehab 4 and other payload experiments such as the Spartan-207 Inflatable Antenna Experiment and the Technology Experiments for Advancing Missions in Space.
- Schuiling, Roelof. "STS-45 Mission Report." *Spaceflight*, October 1992. This article describes STS-45, the mission of Space Shuttle *Atlantis* to carry the first Atmospheric Laboratory for Applications and Science (ATLAS 1) into orbit. ATLAS 1 was designed to conduct studies in atmospheric chemistry, solar radiation, space plasma physics, and ultraviolet astronomy. The article describes launch preparation, payloads, crew members, and activities during the nine-day mission.
- Schuiling, Roelof. "STS-47 Mission Report." *Spaceflight*, April 1993. This article discusses STS-47, Space Shuttle *Endeavour*'s mission to carry Spacelab-J into orbit and to use it to conduct experiments in the Shuttle payload. A joint mission of NASA and Japan's space agency, NASDA, Spacelab-J uses an unpiloted Spacelab module to conduct microgravity investigations in materials and life sciences. The author describes launch preparation, payloads, crew members, and daily activities during the eight-day mission.
- Schuiling, Roelof. "STS-53 Mission Report." *Spaceflight*, March 1993. This article discusses STS-53, Space Shuttle *Discovery*'s mission to deploy a classified DOD satellite and to

conduct two unclassified secondary experiments in the Shuttle payload bay. The two secondary experiments were the Orbital Debris Radar Calibration Spheres and the Shuttle Glow Experiment/Cryogenic Heat Pipe Experiment. The author describes crew members, daily activities, launch preparation, and payloads during the eight-day mission.

Schuiling, Roelof. "STS-54 Mission Report." *Spaceflight*, March 1993. This article discusses STS-54, Space Shuttle *Endeavour*'s mission to deploy the fifth Tracking and Data Relay Satellite (TDRS). A secondary mission was to carry into orbit the Hitchhiker Diffuse X-ray Spectrometer and conduct experiments with it in the Shuttle payload bay. The author describes crew members, daily activities, launch preparation, and payloads during the seven-day mission.

Schuiling, Roelof. "STS-55 Mission Report." *Spaceflight*, July 1993. This article discusses STS-55, Space Shuttle *Columbia*'s mission to carry into orbit the reusable German Spacelab D-2 and to use it in the Shuttle's payload bay to conduct 88 experiments in astronomy, atmospheric physics, Earth observations, materials and life sciences, and technology applications. The author describes crew members, daily activities, launch preparation, and payloads during the 11-day mission.

Schuiling, Roelof. "STS-56 Mission Report." *Spaceflight*, June 1993. This article discusses STS-56, Space Shuttle *Discovery*'s mission to carry Atmospheric Laboratory for Applications and Science 2 (ATLAS 2) into orbit and to use it to conduct experiments in the Shuttle payload bay. ATLAS 2 was designed to collect data on the relationship between the Sun's energy output and Earth's middle atmosphere. The author describes crew members, daily activities, launch preparation, and payloads during the 10-day mission.

Schuiling, Roelof. "STS-57 Mission Report." *Spaceflight*, September 1993. This article discusses STS-57, Space Shuttle *Endeavour*'s mission to carry Spacehab into orbit and to use it to conduct biomedical and materials science experiments in the Shuttle payload bay. On this mission, Shuttle astronauts also conducted a spacewalk to retrieve the European Retrieval Carrier and stow it in the Shuttle's payload bay for return to Earth. The author describes crew members, daily activities, launch preparation, and payloads during the 11-day mission.

Schuiling, Roelof. "STS-58 Mission Report." *Spaceflight*, January 1994. This article discusses STS-58, Space Shuttle *Columbia*'s mission to carry into orbit the second dedicated Spacelab for Life Sciences and to use it to conduct experiments in the Shuttle payload bay. Shuttle crew used Spacelab to conduct 14 experiments in cardiovascular and cardiopulmonary physiology, musculoskeletal physiology, neuroscience, and regulatory physiology. The author describes launch crew members, daily activities, launch preparation, and payloads during the 15-day mission.

Schuiling, Roelof. "STS-59 Mission Report." *Spaceflight*, August 1994. This article discusses STS-59, Space Shuttle *Endeavour*'s mission to carry the Space Radar Laboratory (SRL) into orbit and to use it to conduct experiments in the Shuttle payload bay. The SRL, containing instruments such as the Spaceborne Imaging Radar-C, was designed to study

Earth's ecosystem. The author describes crew members, daily activities, launch preparation, and payloads during the 12-day mission.

Schuiling, Roelof. "STS-60 Mission Report." *Spaceflight*, April 1994. This article describes STS-60, the first mission of the U.S.-Russian Shuttle-*Mir* program and the first Space Shuttle flight of a Russian cosmonaut, Sergei K. Krikalev. STS-60's primary mission was to deploy into low Earth orbit the Wake Shield Facility 1 (WSF-1), a free-flying science platform. However, because of technical difficulties, the crew of Space Shuttle *Discovery* was unable to release WSF-1. STS-60's secondary mission was to carry into orbit the commercially developed Spacehab laboratory module and to use it to conduct experiments in the Shuttle payload bay. The author describes crew members, daily activities, launch preparation, and payloads during the nine-day mission.

Schuiling, Roelof. "STS-62 Mission Report." *Spaceflight*, June 1994. This article discusses STS-62, Space Shuttle *Columbia*'s mission to carry into orbit NASA's U.S. Microgravity Payload-2 (USMP-2) and Office of Aeronautics and Space Technology-2 (OAST-2) and to use them to conduct experiments in the Shuttle payload bay. USMP-2 consisted of five experiments investigating materials processing and crystal growth in microgravity. NASA's OAST-2 featured six experiments focusing on space technology and spaceflight. The author describes crew members, daily activities, launch preparation, and payloads during the 15-day mission.

Schuiling, Roelof. "STS-63 Mission Report." *Spaceflight*, May 1995. This article discusses STS-63, the second mission of the U.S.-Russian Shuttle-*Mir* program. In STS-63, *Discovery* carried out the first rendezvous of a U.S. Space Shuttle with Russia's space station *Mir*. Known as the Near-*Mir* mission, STS-63 carried into orbit Spacehab 3 and the Space Radar Laboratory (SRL). STS-63 was the first flight in which a woman—astronaut Eileen M. Collins—piloted the Shuttle, and the second Shuttle flight carrying a Russian cosmonaut—Vladimir G. Titov. The author describes the nine-day mission's crew members, daily activities, launch preparation, and payloads.

Schuiling, Roelof. "STS-64 Mission Report; Laser Atmospheric Research, Robotic Operations, Untethered Spacewalk." *Spaceflight*, December 1994. This article discusses STS-64, Space Shuttle *Discovery*'s mission to conduct atmospheric research with a laser, use a robot to process semiconductor materials, and perform an untethered spacewalk. The author describes preflight processing, crew members, and Shuttle activities for each of the 12 days that the Shuttle was in space.

Schuiling, Roelof. "STS-65 Mission Report." *Spaceflight*, October 1994. This article discusses STS-65, Space Shuttle *Columbia*'s mission to carry into orbit the second flight of the International Microgravity Laboratory 2 (IML-2). The author describes crew members, daily activities, launch preparation, and payloads during the 16-day mission.

Schuiling, Roelof. "STS-66 Mission Report." *Spaceflight*, March 1995. This article discusses STS-66, the mission of Space Shuttle *Atlantis* to carry into orbit seven instruments on the Atmospheric Laboratory for Applications, as well as the Science-3 Cryogenic

Infrared Spectrometers and Telescopes for the Atmosphere-Shuttle Pallet. The author describes crew members, daily activities, launch preparation, and payloads during the 12-day mission.

Schuiling, Roelof. "STS-67 Mission Report." *Spaceflight*, July 1995. This article discusses STS-67, Space Shuttle *Endeavour*'s mission to carry into orbit the ASTRO Observatory and its three ultraviolet telescopes: the Hopkins Ultraviolet Telescope, the Wisconsin Ultraviolet Photo-Polarimeter Experiment, and the Ultraviolet Imaging Telescope. The author describes crew members, daily activities, launch preparation, and payloads during the 17-day mission.

Schuiling, Roelof. "STS-68 Mission Report." *Spaceflight*, February 1995. This article discusses STS-68, Space Shuttle *Endeavour*'s mission to carry into orbit the Space Radar Laboratory (SRL) and to use it to conduct experiments in the Shuttle payload bay. The SRL was designed to help scientists distinguish between human-induced environmental changes and other natural forms of change. STS-68 was the second flight in 1994 of SRL. NASA flew the SRL during different seasons to compare changes between the first and second flights. The author describes STS-68 crew members, daily activities, launch preparation, and payloads during the 12-day mission.

Schuiling, Roelof. "STS-69 Mission Report." *Spaceflight*, December 1995. This article discusses STS-69, Space Shuttle *Endeavour*'s mission to deploy and retrieve Spartan 201-03 and the Wake Shield Facility 2 (WSF-2), an experimental science platform. The author describes crew members, daily activities, launch preparation, and payloads during the 12-day mission.

Schuiling, Roelof. "STS-70 Mission Report." *Spaceflight*, November 1995. This article discusses STS-70, Space Shuttle *Discovery*'s mission to deploy the Tracking and Data Relay Satellite-G (TDRS-G) and to carry into orbit and to conduct experiments such as the Biological Research in Canister, which investigates the effects of spaceflight on small arthropod animal and plant specimens. The author describes crew members, daily activities, launch preparation, and payloads during the 10-day mission.

Schuiling, Roelof. "STS-73 Mission Report." *Spaceflight*, January 1996. This article discusses STS-73, Space Shuttle *Columbia*'s mission to carry the second United States Microgravity Laboratory (USML-2) into space for microgravity studies in the Shuttle payload. The author describes crew members, daily activities, launch preparation, and payloads during the 17-day mission.

Schuiling, Roelof. "STS-77 Mission Report." *Spaceflight*, August 1996. This article discusses STS-77, Space Shuttle *Endeavour*'s mission to carry into orbit Spacehab 4, and to use it to conduct experiments in agriculture, biotechnology, electronic materials, and polymers in the Shuttle payload bay. STS-77 crew also deployed and retrieved the Spartan-207 free flyer. The author describes crew members, daily activities, launch preparation, and payloads during the 11-day mission.

- Schuiling, Roelof. "STS-78 Mission Report." *Spaceflight*, October 1996. This article discusses STS-78, Space Shuttle *Columbia*'s mission to carry into space the Life and Microgravity Spacelab, to use it to conduct experiments in the Shuttle payload bay, and to study the effects of long-duration spaceflight on human physiology. The author describes crew members, daily activities, launch preparation, and payloads during the 18-day mission.
- Schuiling, Roelof. "STS-80 Mission Report." *Spaceflight*, March 1997. This article discusses STS-80, Space Shuttle *Columbia*'s mission to deploy and retrieve the Orbiting and Retrievable Far and Extreme Ultraviolet Spectrometer-Shuttle Pallet Satellite 2 and the Wake Shield Facility 3 (WSF-3), an experimental science platform. The author describes crew members, daily activities, launch preparation, and payloads during the 18-day mission.
- Schuiling, Roelof. "STS-83 Mission Report." *Spaceflight*, October 1997. This article discusses STS-83, Space Shuttle *Columbia*'s mission to carry into orbit the Microgravity Science Laboratory-1 and to use it to conduct 19 materials science investigations in the Shuttle payload bay. The mission was cut short because of concern over erratic readings from some Shuttle fuel cells. The author describes crew members, daily activities, launch preparation, and payloads during the four-day mission.
- Schuiling, Roelof. "STS-85 Mission Report." *Spaceflight*, November 1997. This article discusses STS-85, Space Shuttle *Discovery*'s mission to deploy and retrieve the Cryogenic Infrared Spectrometers and Telescopes for the Atmosphere-Shuttle Pallet Satellite-2, as well as to carry into space a number of payloads involving secondary experiments. The author describes crew members, daily activities, launch preparation, and payloads during the 11-day mission.
- Schuiling, Roelof. "STS-87 Mission Report." *Spaceflight*, April 1998. This article discusses STS-87, Space Shuttle *Columbia*'s mission to conduct science experiments and to deploy and retrieve the SPARTAN-201-04 free-flyer, a Solar Physics Spacecraft. Experiments conducted in the Shuttle payload bay on the U.S. Microgravity Payload focused on combustion science, fundamental physics, and materials science. The author describes crew members, daily activities, launch preparation, and payloads during the 15-day mission.
- Schuiling, Roelof. "STS-90 Mission Report." *Spaceflight*, August 1998. This article discusses STS-90, Space Shuttle *Columbia*'s mission to study neuroscience. The *Columbia* payload included Neurolab and its 26 experiments related to the nervous system. The author describes crew members, daily activities, launch preparation, and payloads during the 15-day mission.
- Schuiling, Roelof. "STS-91 Mission Report." *Spaceflight*, November 1998. This article discusses STS-91, Space Shuttle *Discovery*'s mission to dock with the Russian space station *Mir* and to deliver cargo, science experiments, and supplies. In addition, the crew moved long-term U.S. experiments that had been aboard *Mir* into *Discovery*'s mid-deck locker

area. The author describes crew members, daily activities, launch preparation, and payloads during the nine-day mission.

Schuiling, Roelof. “STS-93 Launch Delays: Problems on Ascent.” *Spaceflight*, December 1999. This article discusses STS-93, Space Shuttle *Columbia*’s mission to deploy the Chandra X-ray Observatory. STS-93 was the first mission in Space Shuttle history to be commanded by a woman—Eileen M. Collins. The author describes crew members, daily activities, launch preparation, and payloads during the six-day mission.

Schuiling, Roelof. “STS-94 Mission Report.” *Spaceflight*, October 1997. This article discusses STS-94, Space Shuttle *Columbia*’s repeat mission to carry into orbit the Microgravity Science Laboratory-1 (MSL-1) after erratic fuel cell readings shortened MSL-1’s trip aboard STS-83. To prepare for quick relaunch of *Columbia*, NASA serviced MSL-1 in the Shuttle payload bay between STS-83 and STS-94. The author describes crew members, daily activities, launch preparation, and payloads during the 15-day mission.

Schuiling, Roelof. “STS-95: ‘The John Glenn Flight’.” *Spaceflight*, February 1999. This article discusses STS-95, Space Shuttle *Discovery*’s mission to carry into orbit the pressurized Spacehab module and to use it to conduct a variety of scientific experiments in the Shuttle payload bay. On that mission, Shuttle crew members also deployed and retrieved the Spartan free-flyer payload, which gathered measurements of the solar corona and solar wind. Former Mercury program astronaut and U.S. Senator John H. Glenn Jr. was one of the STS-95 crew members, returning to space at the age of 77. The author describes the 10-day mission’s crew members, daily activities, launch preparation, and payloads.

Schuiling, Roelof. “STS-99: Mapping the Earth’s Surface by Radar.” *Spaceflight*, May 2000. This article discusses STS-99, Space Shuttle *Endeavour*’s mission to map the Earth’s surface using radar. The author describes the mission payload, which included the Shuttle Radar Topography Mission, the STS-99 crew, and the crew’s activities on each of the 12 days that *Endeavour* was in space.

Schuiling, Roelof. “STS-107: Columbia’s Final Mission.” *Spaceflight*, April 2003. This article discusses Space Shuttle *Columbia*’s final mission, STS-107, describing launch preparation, payloads, crew members, and daily activities during the 15-day mission to conduct scientific experiments. *Columbia*’s Spacehab RDM held nine commercial payloads involving 21 separate investigations, four payloads for ESA with 14 investigations, one payload/investigation for ISS Risk Mitigation, and 18 payloads supporting 23 investigations for NASA’s Office of Biological and Physical Research. *Columbia* and its crew were lost during reentry over east Texas on 1 February 2003, at about 9:00 a.m. (EST).

Simpson, Clive. “STS-114: Return of the Space Shuttle.” *Spaceflight*, October 2005. This article discusses STS-114, Space Shuttle *Discovery*’s mission to deliver equipment and supplies to the ISS. The author describes crew members, daily activities, launch preparation, and payloads during the 13-day mission.

- Souza, Kenneth, Guy Etheridge, and Paul X. Callahan, eds. *Life into Space: Space Life Sciences Experiments; Ames Research Center, Kennedy Space Center, 1991–1998*. NASA Special Publication 2000-534, Washington, DC, 2000. This book covers various aspects of space life sciences research, including summaries of mission operations, payloads, and experiments developed or managed by NASA's Ames Research Center and NASA's Kennedy Space Center between 1991 and 1998. The book also includes interviews with NASA personnel about various aspects of space life sciences research. Three appendices describe the methods and results of more than 200 flight experiments, the resulting science publications, and associated flight hardware, including illustrations.
- Souza, Kenneth, Robert Hogan, and Rodney Ballard, eds. *Life into Space: Space Life Sciences Experiments. NASA Ames Research Center 1965–1990*. NASA Reference Publication 1372, Washington, DC, 1995. This book profiles the study of biological and biomedical processes using live specimens such as microorganisms, cell cultures, plants, and animals aboard Space Shuttle flights. Early experiments focused on the viability of living systems in the microgravity environment. Later, changes that occur in living systems in response to microgravity were studied. More recently, experiments focused on attempts to understand the mechanisms for changes observed, and to develop methods to oppose those changes. The book contains one-page summaries of more than 200 completed experiments.
- “Spacelab Experiments.” *Spaceflight*, October 1996. This article gives short descriptions of Spacelab experiments during STS-78. There is information about human physiology; plant and animal; materials science; and microgravity experiments.
- The Space Shuttle*. Bethesda, MD: Discovery Communications, 1996. Videocassette (VHS). This video, intended for grades 6–12, shows how NASA prepares the Space Shuttle for liftoff, as well as how on-board experiments open new worlds of opportunity for scientific exploration.
- U.S. General Accounting Office. “Space Station: Plans To Expand Research Community Do Not Match Available Resources.” Report no. GAO/NSIAD-95-33, Washington, DC, November 1994. <http://www.gao.gov/archive/1995/ns95033.pdf> (accessed 8 March 2012). This report focuses on NASA's Earth-orbiting microgravity and life sciences research laboratory. The GAO reports that NASA is focusing on developing a comprehensive research program that emphasizes more ground-based research and uses spaceflight only for research efforts that require a microgravity environment in space.
- Vastag, Brian. “Shuttle Packs \$2 Billion Physics Experiment.” *Washington Post*, 29 April 2011. During STS-134, Space Shuttle *Endeavour* carried the Alpha Magnetic Spectrometer (AMS) to the ISS. The AMS, a US\$2 billion, 7-ton (6.4-tonne or 6,350-kilogram) experiment, will sniff space for cosmic rays, antimatter, dark matter, and other exotic and poorly understood phenomena.

Wilson, Keith T. “From Landing . . . To Launch.” *Spaceflight*, October 1997. This article describes the short turnaround time (94 days) between Space Shuttle *Columbia*’s STS-83 and STS-94 missions, as well as the missions’ prelaunch processing. The staff of NASA’s Kennedy Space Center staff tested and evaluated the Shuttle for its return to space. The Microgravity Science Laboratory remained in the Shuttle between the two flights, the first time that a major payload had remained on-board while the Shuttle was on the ground.

[Link to Part 1 \(1970–1991\), Chapter 9—Science on the Shuttle, Potential and Actual](#)

CHAPTER 9—COMMERCIAL USES OF THE SPACE SHUTTLE

Anselmo, Joseph C. "NASA To Seek Major Shift in U.S. Shuttle Policy." *Aviation Week & Space Technology*, 13 October 1997. This article describes NASA's support for United Space Alliance's lobby to rescind an 11-year-old presidential edict and a provision in U.S. law prohibiting the Space Shuttle from carrying commercial satellites into orbit. United Space Alliance, the venture that manages Shuttle operations, is promoting these policy changes in the hope of completely privatizing Shuttle operations within five years. The expendable launch vehicle industry is likely to oppose the move so that it can retain its monopoly on commercial spacecraft launches.

Calvert, Ken. "Exploration Needs Commercial Space Transportation." *Aviation Week & Space Technology*, 20 February 2005. In this article, U.S. House Representative Kenneth S. Calvert (R-CA), chair of the House Science Committee's Space and Aeronautics Subcommittee, calls for increased commercialization of the space program and a regulatory framework that allows private human spaceflight.

Covault, Craig. "Shuttle Privatization Raises Safety Issues." *Aviation Week & Space Technology*, 24–31 December 2001. NASA's Johnson Space Center has finished an initial privatization assessment involving a large team from NASA's field centers, United Space Alliance, and other Shuttle contractors. The report concludes that continued dependence on support from NASA's civil service poses a greater risk to Shuttle safety than privatization.

Covault, Craig. "Station Commercialization Set as Assembly Flight Readied." *Aviation Week & Space Technology*, 30 November 1998. This article describes Shuttle *Endeavour's* STS-88, the first Space Shuttle mission to assemble the initial elements of the ISS, and discusses NASA's plan to turn the multibillion-dollar ISS into a commercial, fee-for-service facility. According to this scenario, private industry would assume substantial responsibility for the space station.

Covault, Craig. "Unusual Shuttle Operations Advance Commercialization." *Aviation Week & Space Technology*, 2 December 1996. This article describes STS-80 and the difficulty the *Columbia* crew had in releasing the 2-ton (1.8-tonne) commercial Wake Shield Facility (WSF), an experimental science platform, from the Shuttle payload. The WSF, used to produce wafer semiconductors in space, is an example of the Space Shuttle's commercial utility.

Figliola, Patricia Moloney, Carl E. Behrens, and Daniel Morgan. "U.S. Space Programs: Civilian, Military, and Commercial." CRS Issue Brief for Congress, Congressional Research Service, Library of Congress, Washington, DC, 13 June 2006. <http://digital.library.unt.edu/ark:/67531/metacrs10507/?q=IB92011> (accessed 8 March 2012). This report discusses how to manage DOD space programs, avoiding the cost growth and schedule delays that have characterized several recent projects. The authors also describe the appropriate role of the government in facilitating commercial space businesses.

Griffin, Gerry. "As Shuttle Retires, a Vote for Commercial Space Flight." *USA Today*, 6 April 2011. The author reports that, because it will not have low-Earth-orbit transportation capability after the Space Shuttle program ends, NASA will not be able to explore and learn more about space. Furthermore, NASA will not be able to conduct unpiloted spaceflight once the Space Shuttle retires. However, the author believes that the commercial spaceflight industry shows encouraging signs that it may develop the capability of conducting human spaceflight in the near future.

Morring, Frank, Jr. "Commercial Break; NASA Plans COTS-Only Approach for ISS, Dropping Russia's Progress." *Aviation Week & Space Technology*, 21 April 2008. This article reports that NASA officials will discuss with Congress a plan for NASA to continue using Russia's Soyuz crew launch vehicles to transport astronauts to and from the ISS after the final Space Shuttle flight in 2010. NASA does not intend to continue using Russian Progress vehicles for U.S. cargo resupply but plans to use its own Commercial Orbital Transportation System (COTS) program vehicles, which are as yet untested.

Shiga, David. "Cutting the Cost of Spaceflight; NASA Is Looking to Commercial Spacecraft to Lower the Cost of Ferrying Cargo and Crew to the International Space Station." *New Scientist*, 27 September 2008. This article provides an overview of how the Space Shuttle was developed and reports on the commercial space race. The author claims that the spacecraft Dream Chaser, developed by SpaceDev Company, may lower the cost of access to space.

Smith, Marcia S. "Space Launch Vehicles: Government Activities, Commercial Competition, and Satellite Exports." CRS Brief for Congress, Congressional Research Service, Library of Congress, Washington, DC, 31 January 2006. http://digital.library.unt.edu/ark:/67531/metacrs10160/m1/1/high_res_d/IB93062_2006Jan31.pdf (accessed 8 March 2012). This report describes U.S. launch vehicle policies, programs, and issues; the U.S. commercial launch service industry; foreign launch competition; and satellite exports.

The Space Shuttle. DVD. New York: Jaffe Productions, Hearst Entertainment, A & E Home Video, New Video Group, and History Channel, 2004. This DVD program details the development of the Space Shuttle from the 1950s to its triumphant launch in 1981. The program examines the successes and failures of the Shuttle missions and looks at the next generation Shuttle—the futuristic commercial reusable space vehicle X-33 VentureStar.

U.S. Congress. House of Representatives. Committee on Science. Subcommittee on Space and Aeronautics. *Space Shuttle and Space Launch Initiative*. 107th Cong., 2nd sess., 18 April 2002. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest Congressional). This hearing reviews proposed Space Shuttle safety and performance upgrades and examines the NASA Space Launch Initiative, a program for research into the development and commercial applications of advanced and alternative space transportation technologies, including RLV development.

U.S. Congress. House of Representatives. Committee on Science. Subcommittee on Space and Aeronautics. *Space Transportation, Parts I-IV*. 106th Cong., 1st sess., 29 September;

13–27 October 1999. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest Congressional). This hearing reviews the status of NASA’s RLV program, including the X-33 RLV demonstration program; assesses private-sector efforts to develop RLVs using private capital; evaluates proposed safety and performance upgrades to the Space Shuttle; and examines the development of future space transportation systems.

U.S. Congress. Senate. Committee on Commerce, Science, and Transportation. Subcommittee on Science and Space. *Assessing Commercial Space Capabilities*. 111th Cong., 2nd sess., 18 March 2010. http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=111_senate_hearings&docid=f:66983.pdf (accessed 14 March 2012). This hearing examines commercial space capabilities and developments in light of the decision of the George W. Bush administration to discontinue the Space Shuttle program in favor of expanded commercial sector contracting, under NASA oversight, for transportation of astronauts to the ISS and for further exploration.

U.S. General Accounting Office. “Space Transportation: Status of the X-33 Reusable Launch Vehicle Program.” Report no. GAO/T-NSIAD-99-243, Washington, DC, 29 September 1999. <http://www.gao.gov/archive/1999/ns99243t.pdf> (accessed 8 March 2012). The report focuses on the possible phaseout of the Space Shuttle and its replacement with commercial launch services. The GAO remarks that the program will not meet some of its original cost, schedule, and performance objectives because of problems developing technologies for the X-33 VentureStar. In addition, the report states that the X-33 will not carry as much cargo as the Space Shuttle and will have to dock at the ISS more frequently than the Shuttle does.

Williamson, Ray A. “The US-Europe Technology Gap in Space Transportation: The View from the USA.” *Space Policy* 17, no. 1 (February 2001): 27–33. This article reports that competition with Europe’s Ariane launcher has influenced the U.S. decision to privatize the expendable launch vehicle production and operation industry. The author also reports that the U.S. government has decided to fly all government payloads on the Space Shuttle and to market Space Shuttle payloads to the private industry.

Link to Part 1 (1970-1991), Chapter 10—Commercial Uses of the Shuttle

CHAPTER 10—THE SPACE SHUTTLE AND THE MILITARY

- Cassutt, Michael. “Secret Space Shuttles.” *Air & Space*, August 2009. This article discusses several classified U.S. Space Shuttle missions conducted jointly by NASA, the U.S. Air Force, and the intelligence community during the 1980s. One of the missions, STS-27, deployed the first of a series of spy satellites that use radar to observe ground targets, day or night and in any kind of weather.
- Day, Dwayne A. “Department of Defense Returns to Space Shuttle.” *Spaceflight*, February 1997. This article describes a cooperative agreement between NASA and the National Imagery and Mapping Agency to fly a joint mission. The Shuttle Radar Topography Mission will attempt to make an accurate map of the Earth using SIR-C radar.
- Day, Dwayne A. “Out of the Shadows: The Shuttle’s Secret Payloads.” *Spaceflight*, February 1999. This article describes secret payloads launched by NASA on the Space Shuttle under agreements with the National Reconnaissance Office. The article describes the satellites carried in the payloads and the orbits into which the satellites were deployed.
- Day, Dwayne A. “Secret Shuttle Mission Revealed.” *Spaceflight*, July 1998. This article describes the military payload aboard STS-51-J. During Space Shuttle *Atlantis*’s first orbit, the military crew deployed two Defense Satellite Communications Systems-3 satellites. The article describes the mission and the satellites.
- Figliola, Patricia Moloney, Carl E. Behrens, and Daniel Morgan. “U.S. Space Programs: Civilian, Military, and Commercial.” CRS Issue Brief for Congress, Congressional Research Service, Library of Congress, Washington, DC, 13 June 2006. <http://digital.library.unt.edu/ark:/67531/metacrs10507/?q=IB92011> (accessed 8 March 2012). This report discusses how to manage DOD space programs, avoiding the cost growth and schedule delays that have characterized several recent projects. The authors also describe the appropriate role of the government in facilitating commercial space businesses.
- Moltz, James Clay. *The Politics of Space Security: Strategic Restraint and the Pursuit of National Interests*. Palo Alto, CA: Stanford University Press, 2008. This book describes 50 years of space security. The author recounts trends in military space developments and argues that the United States and the former Soviet Union—now Russia—have shown restraint in militarizing space in order to protect access to critical military and civilian assets in orbit. Although the book focuses on space weapons, the author suggests that the Space Shuttle could capture a small spacecraft in orbit, such as a satellite.
- Powell, Joel W. “Secret Shuttle Payloads Revealed.” *Spaceflight*, May 1993. This article describes the DOD payloads aboard STS-27, STS-28, STS-33, STS-36, STS-38, and STS-51. The article describes military Manned Spaceflight Engineers, military personnel who serve as astronauts and are trained as Shuttle payload specialists.

Schuiling, Roelof. “STS-53 Mission Report.” *Spaceflight*, March 1993. This article discusses STS-53, Space Shuttle *Discovery*’s mission to deploy a classified DOD satellite and to conduct two unclassified secondary experiments in the Shuttle payload bay. The author describes crew members, daily activities, launch preparation, and payloads during the eight-day mission.

U.S. General Accounting Office. “Military Space Operations: Common Problems and Their Effects on Satellite and Related Acquisitions.” Report no. GAO-03-825R, Washington, DC, 2 June 2003. <http://www.gao.gov/new.items/d03825r.pdf> (accessed 8 March 2012). This report briefly describes the U.S. military’s use of the Space Shuttle to launch GPS satellites and other space-related systems, such as a strategic surveillance and warning satellite system with an infrared capability to detect ballistic-missile launches.

U.S. General Accounting Office. “Space Station: Information on National Security Applications and Cost.” Report no. GAO/NSIAD-93-208, Washington, DC, May 1993. <http://archive.gao.gov/t2pbat5/149216.pdf> (accessed 8 March 2012). In this report, the GAO explains that the Pentagon has no real need for a piloted space station and could carry out military research using the Space Shuttle. The GAO describes the cost of Space Station Freedom, a NASA project to construct a permanently piloted Earth-orbiting space station in the 1980s. Although approved by President Ronald W. Reagan and announced in the 1984 State of the Union Address, the proposed Space Station Freedom was never constructed or completed as originally designed. After several cutbacks, the remnants of the project became part of the ISS.

Vis, Bert. “The NEREUS Programme.” *Spaceflight*, October 1998. This article discusses oceanographers who have ridden on the Space Shuttle for the Navy Environmental Research Experiment Using Shuttle project. Oceanographers flew aboard STS-41G and STS-61K, using special cameras to observe Earth and the oceans.

Link to Part 1 (1970–1991), Chapter 11—The Shuttle and the Military

CHAPTER 11—SPACE SHUTTLE ASTRONAUTS

- Adamson, Heather. *The Challenger Explosion*. Mankato, MN: Capstone Press, 2006. Ages 9–12. This graphic novel tells the story of Christa McAuliffe and the six other NASA astronauts who lost their lives in the Space Shuttle *Challenger* disaster on 28 January 1986.
- Begley, Sharon, Ginny Carroll, Peter Katel, Catharine Skipp, and Peter Annin. “Down to Earth.” *Newsweek*, 7 October 1996. This article profiles astronaut Shannon W. Lucid, examining her record 188 days in space (179 days aboard *Mir* and nine days total on Space Shuttle trips to and from *Mir*) and her health after returning to Earth in September 1996. The authors also discuss Lucid’s education and her career background.
- Bredeson, Carmen. *Shannon Lucid Space Ambassador*. Brookfield, CT: Millbrook Press, 1998. <http://www.barnesandnoble.com/s/Shannon-Lucid-Space-Ambassador-?keyword=Shannon+Lucid+Space+Ambassador.&store=ebook> (accessed 8 March 2012). This electronic book chronicles the life of astronaut Shannon W. Lucid, from her childhood in Oklahoma, through her various Space Shuttle missions, to her six months aboard the *Mir* space station.
- Burgess, Colin. *Australia’s Astronauts: Countdown to a Spaceflight Dream*. Berowra, NSW: The Communications Agency, 2009. This book tells the stories of the three Australian astronauts, Philip K. Chapman, Paul D. Scully-Power, and Andrew S. W. Thomas, recounting their experiences and explaining their roles in the space programs of the United States and Russia. Chapman did not fly aboard a Space Shuttle but was the first Australian-born person selected as a scientist-astronaut by NASA. Scully-Power flew on STS-41-G as a payload specialist and was the first Australian-born person to journey into space. Thomas flew aboard STS-77 as a payload commander and aboard STS-77 as a mission specialist. Thomas also trained at the Gagarin Cosmonaut Training Center in Star City, Russia. The book also discusses missed opportunities for other Australian astronauts to fly in space as part of NASA’s international payload specialist program.
- Chien, Philip. *Columbia—Final Voyage: The Last Flight of NASA’s First Space Shuttle*. Chichester, UK: Praxis Publishing, 2006. This book explains STS-107, *Columbia*’s final mission, a “free flyer” mission in which NASA planned for the crew to spend 16 days in orbit, performing dozens of scientific experiments. The book devotes one chapter to each STS-107 astronaut. The author criticizes the media for covering the mission only after the catastrophe had occurred.
- Cole, Michael D. *The Columbia Space Shuttle Disaster: From First Liftoff to Tragic Final Flight*. Rev. ed. Berkeley Heights, NJ: Enslow Publishers, 2003. This book contains technical details about the Space Shuttle, as well as personal information about the astronauts aboard *Columbia* on its final mission, STS-107. Photographs introduce young readers to the crew and help them understand the events that led to the tragic loss of the spacecraft and its crew.

- Covault, Craig. "Station Training Focus: 'Building on the Fly'." *Aviation Week & Space Technology*, 2 September 1996. This article describes astronaut and cosmonaut training for those who will build and live in the ISS. The author presents information about the Space Shuttle Training Facility at NASA's Johnson Space Center in Houston, Texas, and the Neutral Buoyancy Laboratory underwater training facility. He also explains EVA training requirements. In addition, the article discusses the costs of the ISS and its assembly schedule.
- DiGregorio, Barry. "The Right Stuff; Grounded for More Than Two Years After the Loss of Columbia, the Space Shuttle Is Due To Take to the Skies Again Sometime in July." *New Scientist*, 14 May 2005. This article presents an interview with Eileen M. Collins, Commander of *Discovery* for the first flight of the Space Shuttle since *Columbia's* accident. Collins is confident that the redesign of the Shuttle's external fuel tank and the removal of large pieces of foam from the front section of the tank will protect *Discovery* from the type of accident that caused the loss of *Columbia*.
- Foale, Colin. *Waystation to the Stars: The Story of Mir, Michael, and Me*. London: Headline Book Publishing, 2000. This book, written by the father of British-American astronaut C. Michael Foale, describes the astronaut's activities and experiences on *Mir* for five months in 1997. During his stay on *Mir*, Foale had to deal with fire, collision, and computer failure.
- French, Francis. "The Unassuming Journey of Charlie Bolden." *Spaceflight*, March 2002. This article recounts how current NASA Administrator Charles F. Bolden Jr. overcame personal obstacles to attend the U.S. Naval Academy and become a U.S. Marine Corps aviator before joining the astronaut program and becoming a Space Shuttle astronaut.
- Harris, Bernard A., Jr. *Dream Walker: A Journey of Achievement and Inspiration*. Austin, TX: Greenleaf Book Press Group, 2010. This book by Bernard A. Harris Jr., Mission Specialist on STS-55 and Payload Commander on STS-63, describes Harris's modest background and his experiences in college, medical school, and during training as a NASA flight surgeon. Harris was the first African American to walk in space.
- Hawaleshka, Danylo. "A Hero in Orbit: John Glenn's Return Sparks Interest in the Space Saga." *Maclean's*, 2 November 1998. This article examines reactions to the 77-year-old John H. Glenn Jr.'s inclusion in a Space Shuttle *Discovery* mission, STS-95. In 1962 Glenn became the first American to orbit the Earth. Although critics claim that Glenn's return to space on board the Space Shuttle is simply a publicity stunt, NASA asserts that Glenn's participation in the flight is a contribution to science. Monitoring the oldest man ever to fly in space will help NASA investigate the detrimental effects of microgravity on astronauts and could also help improve health care for the elderly.
- Holden, Henry M. *The Tragedy of the Space Shuttle Challenger*. Berkeley Heights, NJ: MyReportLinks.com Books, 2004. Ages 9–12. This book describes events surrounding the explosion of Space Shuttle *Challenger* in 1986 and discusses the investigation of this

disaster. The author tells the stories of the seven astronauts who died. The book also includes Internet links to related Web sites, source documents, and photographs.

Jones, Thomas D. "The Future of NASA's Astronaut Corps." *Aerospace America*, October 2010. In this article, a former astronaut compares the number of astronauts at NASA when he flew his first Shuttle flight in 1994 with the number of astronauts that NASA will need after the Space Shuttles retire. Jones also discusses astronaut hiring and training for ISS missions.

Kevles, Bettyann Holtzmann. *Almost Heaven: The Story of Women in Space*. New York, NY: Basic Books, 2003. This book tells the stories of the first women to face the risks of space travel, discussing their contributions to science and to society. The author traces the careers of several female astronauts and cosmonauts who broke new trails in a traditionally male profession. The publisher issued an updated paperback edition in 2006.

Kosova, Weston, Sam Seibert, Seth Mnookin, and Joshua Hammer. "The Right Stuff." *Newsweek*, 10 February 2003. This article profiles the astronauts who perished on *Columbia*: Richard D. Husband, William C. McCool, Michael P. Anderson, Kalpana Chawla, David M. Brown, Laurel B. Clark, and Ilan Ramon.

Lenehan, Anne E. *Story: The Way of Water*. Berowra, NSW: The Communications Agency, 2004. This book is about astronaut Franklin Story Musgrave, who flew aboard STS-6, STS-51, STS-33, STS-44 STS-61, and STS-80. Musgrave is a doctor, space physiologist, pilot, astronaut, poet, philosopher, and artist.

Lieurance, Suzanne. *The Space Shuttle Challenger Disaster in American History*. Berkeley Heights, NJ: Enslow Publishers, 2001. Ages 9–12. Grades 5–7. After recounting the events of the morning that Space Shuttle *Challenger* exploded, the author places the *Challenger's* mission in historical context. She summarizes the U.S. space program up to that time, profiles each of the astronauts assigned to the *Challenger* crew and discusses the selection and training of civilian teacher Christa McAuliffe for the mission.

Linenger, Jerry M. *Off the Planet: Surviving Five Perilous Months Aboard the Space Station Mir*. New York: McGraw-Hill, 2000. In this book, astronaut Jerry M. Linenger describes his background and his experience training for and living aboard *Mir*. Linenger recounts his efforts to survive 132 days aboard the decaying and unstable Russian space station *Mir*.

McNair, Carl S., and H. Michael Brewer. *In the Spirit of Ronald E. McNair, Astronaut: An American Hero*. Atlanta, GA: Publishing Associates, 2005. This book describes the life and career of Ronald E. McNair, who died in STS-51's *Challenger* tragedy. From a modest background, McNair graduated from college and earned a PhD in physics, becoming one of the world's first African American Space Shuttle astronauts. McNair flew on missions STS-41 and STS-51.

Melady, John. *Canadians in Space: The Forever Frontier*. Toronto: Dundurn Press, 2009. This book, commemorating the 25th anniversary of the flight of the first Canadian

astronaut, Marc Garneau, focuses on the eight Canadian astronauts who have flown on the Space Shuttle.

Mullane, R. Mike. *Liftoff! An Astronaut's Dream*. Parsippany, NJ: Silver Burdett, 1995. The author, a former astronaut, describes his experiences in space and shares his ideas about the future of spaceflight.

Musgrave, Story, Lance Lenehan, and Anne Lenehan. *The NASA Northrop T-38: Photographic Art from an Astronaut Pilot*. Kissimmee, FL: Lannistoria, 2008. For decades, Space Shuttle astronauts have trained in the Northrop T-38 Talon, a twin-engine supersonic jet. In this book, astronaut Franklin Story Musgrave shares with space enthusiasts and photographers his private collection of photographs of the Northrop T-38 Talon. Accompanying the images, Musgrave's first-hand account of people and airplanes provides a fascinating insight into the culture of NASA's flying world.

NASA. Johnson Space Center. *STS-107 Memories*. Washington, DC: U.S. Government Printing Office, 2006. CD. This CD, commemorating the seven crew members who lost their lives on Space Shuttle *Columbia* in February 2003, features biographies and photographs of the crew as they worked and trained together.

Reichhardt, Tony. "Shuttlenauts: The Faces of the Space Shuttle Era." *Air & Space*, January 2011. The author discusses the Shuttle's role in the construction of the ISS and examines the careers of several astronauts who spent time on the Space Shuttle, including former Navy pilot Robert L. Crippen and Shuttle Commander Peggy A. Whitson.

Reichhardt, Tony, ed. *Space Shuttle: The First 20 Years—The Astronauts' Experiences in Their Own Words*. New York: Dorling Kindersley, 2002. This book, compiled by the editors of *Air & Space* and *Smithsonian* magazines, documents the history of the Space Shuttle program based on astronauts' anecdotes and reminiscences. The book includes 77 first-person accounts, including astronauts' descriptions of their experiences in zero gravity and their fear of failing in their missions.

Rumerman, Judy A. *Human Space Flight: A Record of Achievement, 1961–1998*. Monographs in Aerospace History no. 9, NASA History Division, Office of Policy and Plans, NASA Headquarters, Washington, DC, August 1998. <http://history.nasa.gov/40thann/humanspf.htm> (accessed 8 March 2012). This book describes the United States' record of achievement in human spaceflight, from the *Mercury* experimental flights, to the *Apollo* Moon landings, to the current flights of the Space Shuttle. The author provides brief mission descriptions and a list of crew members for Shuttle flights STS-1 through STS-94.

Saslow, Rachel. "A Man Who Spent Years at NASA and 35 Days in Space." *Washington Post*, 5 July 2011. The author interviews former Space Shuttle astronaut Piers J. Sellers about his memories of spaceflight and the end of the U.S. Space Shuttle program.

Schefter, Jim. "The Right Stuff-Again." *Popular Science*, May 1998. This article profiles U.S. Senator John H. Glenn Jr., the first American astronaut to orbit the Earth in the 1960s, discussing his preparations for his 1998 mission on the Space Shuttle.

Schuiling, Roelof. "STS-63 Mission Report." *Spaceflight*, May 1995. This article discusses STS-63, the second mission of the U.S.-Russian Shuttle-*Mir* program. In STS-63, *Discovery* carried out the first rendezvous of a U.S. Space Shuttle with Russia's space station *Mir*. Known as the Near-*Mir* mission, STS-63 carried into orbit Spacehab 3 and the Space Radar Laboratory (SRL). STS-63 was the first flight in which a woman—astronaut Eileen M. Collins—piloted the Shuttle, and the second Shuttle flight carrying a Russian cosmonaut—Vladimir G. Titov. The author describes the nine-day mission's crew members, daily activities, launch preparation, and payloads.

Schuiling, Roelof. "STS-95: 'The John Glenn Flight'." *Spaceflight*, February 1999. This article discusses STS-95, Space Shuttle *Discovery*'s mission to carry into orbit the pressurized Spacehab module and to use it to conduct a variety of scientific experiments in the Shuttle payload bay. On that mission, Shuttle crew members also deployed and retrieved the Spartan free-flyer payload, which gathered measurements of the solar corona and solar wind. Former Mercury program astronaut and U.S. Senator John H. Glenn Jr. was one of the STS-95 crew members, returning to space at the age of 77. The author describes the 10-day mission's crew members, daily activities, launch preparation, and payloads.

Schwartz, John. "Astronaut Profiles." *New York Times*, 7 August 2007. This article profiles the seven members of the crew of Space Shuttle *Endeavour* for STS-118, which launched on 8 August 2007.

Schwartz, John. "The Astronauts of STS-120." *New York Times*, 23 October 2008. This article profiles crew members of STS-120, who launched aboard Shuttle *Discovery* on 23 October 2007.

Stott, Carole. *Fly the Space Shuttle*. New York: Dorling Kindersley, 2001. Ages 9 and older. In this book, aimed at a juvenile audience, the reader is invited to pretend that he or she is training as an astronaut to fly on a Space Shuttle mission. The reader is introduced to other members of the crew and learns about the fun and the difficulties of living in a weightless environment, maneuvering the Shuttle orbiter in space, and deploying a satellite. The book includes an easy-to-make, three-dimensional Space Shuttle model. Pull-out and lift-the-flap sections show how the Shuttle works and how it is used.

"STS-107 Crew Profiles." *Spaceflight*, April 2003. This one-page article describes the seven crew members of STS-107, who perished in the *Columbia* tragedy, providing brief biographical information and a picture of each crew member.

Sweetman, Bill. "Seen from Washington." *Interavia Business & Technology*, May 1999. This article focuses on developments related to aerospace industries in the United States as of May 1999, including NASA's plan to launch a Space Shuttle mission with a crew of women only. The author takes a negative view of an all-female Space Shuttle crew.

- U.S. General Accounting Office. "Astronaut Utilization." Report no. GAO/NSIAD-93-114R, Washington, DC, 12 January 1993. <http://archive.gao.gov/d36t11/148414.pdf> (accessed 8 March 2012). In this report, the GAO finds that NASA has no written policies or procedures to determine the size of the astronaut corps and that NASA's flight rates have been lower than anticipated, decreasing the need for pilots. Furthermore, the report states that the nature of space missions has changed, from simple satellite deployments to a variety of space-based activities, increasing the need for mission specialists.
- Van Den Berg, Anne. "Story Musgrave." *Spaceflight*, November 1996. This article profiles NASA astronaut Franklin Story Musgrave, Mission Specialist for STS-80. When that mission is complete, Musgrave will have flown on all five Space Shuttles and will also have flown on more Shuttle flights than any other astronaut.
- Vogt, Gregory. *John Glenn's Return to Space*. Brookfield, CT: Millbrook Press, 2000. Grades 5–8. This book describes John H. Glenn Jr.'s early days as an astronaut and tells the story of his 1962 spaceflight in Friendship 7, as the first American to orbit Earth. The author recounts Glenn's return to space in 1998 at the age of 77 aboard Space Shuttle *Discovery*, emphasizing the extraordinary contrast between Glenn's first orbit around Earth and his recent Shuttle flight and using Glenn's story to symbolize the evolution of the American space program. The author also explains that Glenn joined the *Discovery* crew as a senior citizen so that he could participate in experiments aimed at measuring the effects of space travel on the human body.
- Whitehouse, Patricia. *Living in Space*. Chicago: Heinemann Library, 2004. Ages 4–8. Grades 1–3. This book gives readers a glimpse of the experiences astronauts have while living in space and on the Space Shuttle. It describes Shuttle astronauts' daily routines, and explains how they receive air, water, and food, and reveals what happens to their garbage.
- Whitehouse, Patricia. *Working in Space*. Chicago, IL: Heinemann Library, 2003. Ages 6 and up. This introduction to working in space discusses Space Shuttle astronaut training and different kinds of jobs in space, describing what it is like to leave Earth aboard a Space Shuttle, work in microgravity, fix satellites, work outside a Space Shuttle, and put on a spacesuit. The author also discusses what it might be like to work on other worlds. The book includes a section of space facts.
- Wilson, Scott. "Obama Picks Shuttle Veteran To Be First Black NASA Chief." *Washington Post*, 24 May 2009. The article announces that President Barack H. Obama has nominated former Marine aviator and Space Shuttle astronaut Charles F. Bolden Jr. to head NASA. As NASA's first African American Administrator, Bolden will oversee a broad review of NASA's ambitions for piloted and robotic space exploration.
- Woodmansee, Laura S. *Women Astronauts*. Burlington, ON: Apogee Books, 2002. This book features stories and interviews with many past and current female astronauts, including Shuttle astronauts Ellen S. Baker, Kalpana Chawla, Eileen M. Collins, Bonnie J. Dunbar, Anna L. Fisher, Linda M. Godwin, Ellen Ochoa, and Heidemarie M. Stefanyshyn-Piper.

The book describes their childhoods, training, everyday lives, and missions, explaining the determination, commitment, and expertise required to work in the space industry.

[Link to Part 1 \(1970–1991\), Chapter 12—Shuttle Astronauts](#)

CHAPTER 12—THE SPACE SHUTTLE AND INTERNATIONAL RELATIONS

Behrens, Carl, and Mary Beth Nitikin. “Extending NASA’s Exemption from the Iran, North Korea, and Syria Nonproliferation Act.” CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 1 October 2008.

http://assets.opencrs.com/rpts/RL34477_20081001.pdf (accessed 8 March 2012). This report discusses the Iran Nonproliferation Act of 2000, enacted to prevent foreign transfers to Iran of weapons of mass destruction, missile technology, and advanced conventional weapons technology, particularly transfers from Russia. Section 6 of the Act bans U.S. payments to Russia in connection with the ISS unless the President of the United States determines that Russia is taking steps to prevent the proliferation of weapons to Iran.

Burgess, Colin. *Australia’s Astronauts: Countdown to a Spaceflight Dream*. Berowra, NSW: The Communications Agency, 2009. This book tells the stories of the three Australian astronauts, Philip K. Chapman, Paul D. Scully-Power, and Andrew S. W. Thomas, recounting their experiences and explaining their roles in the space programs of the United States and Russia. The book also discusses missed opportunities for other Australian astronauts to fly in space as part of NASA’s international payload specialist program.

Burgess, Colin. “Lost Mission.” *Spaceflight*, June 1999. This article describes how the loss of Space Shuttle *Challenger* in 1986 affected the future missions of Indonesian astronaut candidates for Space Shuttle missions. The U.S. government offered to train an Indonesian astronaut who would be a crew member on a mission to launch an Indonesian satellite. Post-tragedy launch delays forced NASA to launch the Indonesian satellite on an unmanned booster so the Indonesian astronaut candidates did not get to fly a Shuttle mission. The article also portrays the two astronaut candidates chosen for the mission, Taufik Akbar and Pratiwi Sudarmono.

Fischer, Hans-Jurgen, and German A. Zoeschinger. “Planning and Co-ordination of Space Shuttle Attitudes and Trajectory for Spacelab Mission D-2.” *Journal of the British Interplanetary Society* 47, no. 7 (July 1994): 260–265. The article describes how the German Space Operations Center helped plan and coordinate a Space Shuttle payload.

Melady, John. *Canadians in Space: The Forever Frontier*. Toronto: Dundurn Press, 2009. This book, commemorating the twenty-fifth anniversary of the flight of the first Canadian astronaut, Marc Garneau, focuses on the eight Canadian astronauts who have flown on the Space Shuttle.

Pletser, Vladimir. “ESA’s Fluid Physics Experiments on STS-78.” *Spaceflight*, October 1996. This article describes the fluid physics experiments that ESA conducted aboard *Columbia* during STS-78 in 1996.

Rouss, Sylvia A. *Reach for the Stars: A Little Torah’s Journey*. New York: Devora Publishing, 2004. Grades 3–5. This is a true story of the miniature Torah that Israeli astronaut Ilan Ramon carried with him on Space Shuttle *Columbia*’s mission, STS-107. This unique

Torah survived the Holocaust, along with its guardian, Joachim Joseph. Years later, Ilan Ramon became close friends with Joachim Joseph and agreed to take the Torah with him on his journey into space.

Sadeh, Eligar, James P. Lester, and Willy Z. Sadeh. “Modeling International Cooperation for Space Exploration.” *Space Policy* 12, no. 2 (August 1996): 207–223. Based on their belief that international cooperation is a prerequisite for space exploration in the twenty-first century, the authors propose a theoretical framework for international cooperation among economic, political, scientific, and technological entities.

Schuiling, Roelof. “STS-46 Mission Report.” *Spaceflight*, January 1993. This article discusses STS-46, the mission of Space Shuttle *Atlantis* to deploy ESA’s European Retrievable Carrier and to operate the joint project of NASA and Agenzia Spaziale Italiana (the Italian space agency)—the Tethered Satellite System. The author describes launch preparation, payloads, crew members, and activities during the eight-day mission.

Schuiling, Roelof. “STS-47 Mission Report.” *Spaceflight*, April 1993. This article discusses STS-47, Space Shuttle *Endeavour*’s mission to carry Spacelab-J into orbit and to use it to conduct experiments in the Shuttle payload. A joint mission of NASA and Japan’s space agency, NASDA, Spacelab-J uses an unpiloted Spacelab module to conduct microgravity investigations in materials and life sciences. The author describes launch preparation, payloads, crew members, and daily activities during the eight-day mission.

Schuiling, Roelof. “STS-55 Mission Report.” *Spaceflight*, July 1993. This article discusses STS-55, Space Shuttle *Columbia*’s mission to carry into orbit the reusable German Spacelab D-2 and to use it in the Shuttle’s payload bay to conduct 88 experiments in astronomy, atmospheric physics, Earth observations, materials and life sciences, and technology applications. The author describes crew members, daily activities, launch preparation, and payloads during the 11-day mission.

Schuiling, Roelof. “STS-57 Mission Report.” *Spaceflight*, September 1993. This article discusses STS-57, Space Shuttle *Endeavour*’s mission to carry Spacehab into orbit and to use it to conduct biomedical and materials science experiments in the Shuttle payload bay. On this mission, Shuttle astronauts also conducted a spacewalk to retrieve the European Retrievable Carrier and stow it in the Shuttle’s payload bay for return to Earth. The author describes crew members, daily activities, launch preparation, and payloads during the 11-day mission.

Schuiling, Roelof. “STS-72 Mission Report.” *Spaceflight*, April 1996. This article discusses STS-72, Space Shuttle *Endeavour*’s mission to retrieve the Japanese Space Flyer Unit satellite and to deploy and retrieve the Office of Aeronautics and Space Technology Flyer spacecraft. The author describes crew members, daily activities, launch preparation, and payloads during the 10-day mission.

Schuiling, Roelof. “STS-75 Mission Report.” *Spaceflight*, June 1996. This article discusses STS-75, Space Shuttle *Columbia*’s mission to deploy and retrieve the joint U.S.-Italian

Tethered Satellite System. The crew had deployed the satellite and had begun gathering scientific data when the tether snapped on flight day three, as the satellite was just short of full deployment by about 12.8 miles. The author describes crew members, daily activities, launch preparation, and payloads during the 15-day mission.

Stine, Deborah D. “U.S. Civilian Policy Priorities: Reflections 50 Years After Sputnik.” CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 2 February 2009. <http://www.fas.org/sgp/crs/space/RL34263.pdf> (accessed 7 March 2012). This report explains how the actions of other nations—the Soviet Union’s launch of Sputnik, for example—and the actions of U.S. commercial organizations have influenced U.S. civilian space policy today. The report concludes with a discussion of possible priorities for future U.S. civilian space policy.

U.S. Congress. House of Representatives. Committee on Science. *U.S.-Japanese Cooperation in Human Spaceflight*. 104th Cong., 1st sess., 19 October 1995. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest Congressional). This hearing provides background on U.S.-Japanese cooperative space programs, including the status of these programs and the outlook for their future. Specifics of Japanese participation in ISS scientific experiments are also included.

Williamson, Ray A. “The US-Europe Technology Gap in Space Transportation: The View from the USA.” *Space Policy* 17, no. 1 (February 2001): 27–33. This article reports that competition with Europe’s Ariane launcher has influenced the U.S. decision to privatize the expendable launch vehicle production and operation industry. The author also reports that the U.S. government has decided to fly all government payloads on the Space Shuttle and to market Space Shuttle payloads to private industry.

Link to Part 1 (1970–1991), Chapter 13—The Shuttle in International Perspective

CHAPTER 13—MANAGEMENT OF THE SPACE SHUTTLE PROGRAM

Abbey, George, and Neal Lane. *United States Space Policy: Challenges and Opportunities*. Cambridge, MA: American Academy of Arts and Sciences, 2005. <http://carnegie.org/fileadmin/Media/Publications/PDF/spaceUS.pdf> (accessed 3 April 2012). This publication identifies challenges and opportunities for the U.S. space program, paying particular attention to unintended consequences of current policies. The authors recommend extending the scheduled end date of Space Shuttle missions from 2010 to 2015, so that NASA will not lose the capability of piloted spaceflight.

“At 15, a Safer, Cheaper Shuttle.” *Aviation Week & Space Technology*, 8 April 1996. This article examines the Space Shuttle program’s status at the fifteenth anniversary of its creation in 1996. Comparing the current space program to the program originally envisioned—as an inexpensive means of access to space—the author discusses how the program has changed over time, explaining how it has failed to meet its early goals.

Blomberg, Richard D. “Report on Shuttle Safety.” *Ad Astra*, August 2002. This article summarizes the Space Shuttle safety issues addressed by NASA’s Aerospace Safety Advisory Panel (ASAP), along with the panel’s findings and recommendations regarding Space Shuttle plans and budgetary requests. The author also makes recommendations regarding ground infrastructure and launch workforce.

Covault, Craig. “Flight of the Phoenix.” *Aviation Week & Space Technology*, 11 July 2005. This article discusses the repair and maintenance of Space Shuttle *Discovery* by NASA and contractor personnel. The author reports that the immediate fate of thousands of Shuttle-related aerospace jobs across the United States is riding on the success or failure of *Discovery*’s return to flight and subsequent Shuttle missions.

Covault, Craig. “NASA’s Eroding Safety.” *Aviation Week & Space Technology*, 12 May 2003. Covault predicts that the *Columbia* Accident Investigation Board’s (CAIB’s) report will cite serious deficiencies in NASA’s overall safety program as a root cause or significant contributing factor to the loss of Space Shuttle *Columbia* and its crew. The author anticipates that the report will question whether NASA’s oversight of the spacecraft was effective, once NASA had transferred specific duties of vehicle quality control to the United Space Alliance, as required under the Space Flight Operations Contract.

Covault, Craig. “New Shuttle Concerns Aired.” *Aviation Week & Space Technology*, 15 July 1996. The author reports that the White House, NASA, and the aerospace industry are assessing the effect of an independent Aerospace Safety Advisory Panel (ASAP) report that raises serious Space Shuttle safety issues, including the potential for increased risk of a Shuttle accident. The concerns stem from NASA’s plan to reduce its costs by shifting additional operational responsibilities to the commercial contractor United Space Alliance. NASA and Thiokol are in the midst of a major investigation of the Space Shuttle’s solid rocket motors to determine why hot gas penetrated into new areas of all six-field joints on the two boosters that launched the orbiter *Columbia*.

- Covault, Craig. "Shuttle Shakeup Eyed for Cost, Safety Goals." *Aviation Week & Space Technology*, 23 September 2002. This article describes NASA's efforts to reform management and procurement policies and practices for all U.S. piloted space projects. In replacing the Shuttle, NASA hopes to shift from privatized to competitive sourcing. However, NASA has discovered that these efforts must be closely joined to ISS and Space Launch Initiative developments.
- Figliola, Patricia Moloney, Carl E. Behrens, and Daniel Morgan. "U.S. Space Programs: Civilian, Military, and Commercial." CRS Issue Brief for Congress, Congressional Research Service, Library of Congress, Washington, DC, 13 June 2006. <http://digital.library.unt.edu/ark:/67531/metacrs10507/?q=IB92011> (accessed 8 March 2012). This report discusses how to manage DOD space programs, avoiding the cost growth and schedule delays that have characterized several recent projects. The authors also describe the appropriate role of the government in facilitating commercial space businesses.
- Lawler, Andrew. "NASA Budget Soars as Space Shuttle Lands." *Science* 309, no. 5734 (22 July 2005): 540–541. This article reports the increase of NASA's 2007 budget by approximately US\$1 billion.
- Lawler, Andrew. "NASA May Cut Shuttle Flights and Reduce Science on Station." *Science* 309, no. 5734 (22 July 2005): 540–541. The article focuses on NASA's plan to curtail Space Shuttle flights and to reduce science research activities on the ISS.
- Lawler, Andrew. "Rising Cost of Shuttle and Hubble Could Break NASA Budget." *Science* 305, no. 5692 (24 September 2004): 1882–1883. This article reports that NASA's Associate Administrator of Science, Alphonso V. Diaz, has directed his managers to reduce space and Earth science programs by US\$400 million, so that NASA can resume Space Shuttle flights.
- Morgan, Daniel, and Carl E. Behrens. "National Aeronautics and Space Administration: Overview, FY 2008 Budget in Brief, and Key Issues for Congress." CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 14 March 2007. http://assets.opencrs.com/rpts/RS22625_20070314.pdf (accessed 8 March 2012). This report discusses the FY 2008 US\$17.309 billion budget request for NASA, an increase of 6.5 percent from the FY 2007 appropriation of US\$16.247 billion. Other issues addressed include the President's Vision for Space Exploration, development of new vehicles for human spaceflight, plans for the transition to these vehicles after NASA retires the Space Shuttle in 2010, and NASA's efforts to balance its priorities between human exploration and its other activities in science and aeronautics.
- Morgan, Daniel, and Carl E. Behrens. "National Aeronautics and Space Administration: Overview, FY 2009 Budget, and Issues for Congress." CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 26 February 2008. http://assets.opencrs.com/rpts/RS22818_20080226.pdf (accessed 8 March 2012). This report discusses NASA's FY 2009 budget request of US\$17.614 billion, an increase of 1.8 percent from the FY 2008 appropriation of US\$17.309 billion. The report explains

the importance of implementing the President's Vision for Space Exploration, including the development of new vehicles for human spaceflight, plans for the transition to these vehicles after NASA retires the Space Shuttle in 2010, and NASA's efforts to balance its priorities between human exploration and its other activities in science and aeronautics.

McCurdy, Howard E. "The Cost of Space Flight." *Space Policy* 10, no. 4 (November 1994): 277–289. The author discusses the costs of the human spaceflight program and NASA's efforts to reduce costs.

Morring, Frank, Jr. "Off the Ground; NASA Included Foreign Rockets, Shuttle-Derived Vehicles as Possible Launchers for Exploration." *Aviation Week & Space Technology*, 28 June 2004. This article explains how contractors could cobble together exploration launch vehicles from Space Shuttle components to save development costs. For instance, NASA calculates that an unpiloted vehicle based on Space Shuttle solid rocket motors, Space Shuttle main engines (SSMEs), and other hardware could lift from 60 to 100 tonnes (66 to 110 tons).

"NASA Loses Head After Budget Boost." *Interavia Business & Technology*, Winter 2004. The article describes congressional budget increases at NASA. Congressional conferees voice concern over future cost overruns on the ISS and how overruns will affect the Space Shuttle.

"Old, Unsafe, and Costly." *Economist*, 30 August 2003. The article comments on proposals to discontinue the Space Shuttle program because of problems in Shuttle design, the costs of the program, and the safety risk of launching these space vehicles into space. In addition, the article discusses the possibility that the Space Shuttle program is having a negative effect on the development of a private space industry. The author believes that the Shuttle program has failed and that NASA should concentrate on developing high-risk technologies with the potential to transform routine space travel for people and equipment.

Pielke, Roger A., Jr. "A Reappraisal of the Space Shuttle Programme." *Space Policy* 9, no. 2 (12 February 2003): 133–157. Congressional and presidential support for the Space Shuttle has been consistently generous despite NASA's inconsistent and flawed justifications for the program. NASA needs to have more rigorous congressional oversight and to develop smaller, quicker, and more independent civil space programs.

Pielke, Roger A., Jr. "Space Shuttle Value Open to Interpretation." *Aviation Week & Space Technology*, 26 July 1993. The article explains Space Shuttle costs from the point of view of a taxpayer, a space policymaker, and a national policymaker.

Schwartz, John. "Report Says Space Program Is Lacking Money and Focus." *New York Times*, 23 June 2005. Two influential experts, George W. S. Abbey, Director of NASA's Johnson Space Center in Houston from 1995 to 2001, and Neal F. Lane, Science Advisor to President William J. Clinton from 1998 to 2001, predict that the President George W. Bush administration's plans for human space exploration are doomed to failure without a major infusion of money and fundamental changes in space policy.

- Sietzen, Frank, Jr. “The Future of Space Transportation: Is It Expendable? Reusables? Or the Shuttle? Why Not All Three?” *Ad Astra*, August 2002. This short article discusses the future of the Space Shuttle and Congress’s failure to increase NASA’s budget, despite rising ISS costs.
- Smith, Marcia S. “National Aeronautics and Space Administration: Overview, FY 2004 Budget in Brief, and Issues for Congress.” CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 23 June 2003. http://assets.opencrs.com/rpts/RS21430_20030728.pdf (accessed 12 March 2012). This report focuses on NASA’s US\$15.5 billion FY 2004 budget request. The author discusses the investigation of the Space Shuttle *Columbia* tragedy on 1 February 2003 and its implications for NASA and for the space program as a whole.
- Smith, Marcia S., and Daniel Morgan. “The National Aeronautics and Space Administration: Overview, FY 2005 Budget in Brief, and Key Issues for Congress.” CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 5 October 2004. <http://www.fas.org/spp/civil/crs/RS21744.pdf> (accessed 8 March 2012). This report describes NASA’s FY 2005 budget request for US\$16.2 billion, a 5.6 percent increase over its FY 2004 appropriation of US\$15.4 billion. The report also discusses the new space exploration goals that President George W. Bush announced on 14 January 2004, NASA’s plans to return the Space Shuttle to flight status following the Space Shuttle *Columbia* accident, and the health of NASA’s aeronautics research program.
- Smith, Marcia S., and Daniel Morgan. “The National Aeronautics and Space Administration’s FY 2005 Budget Request: Description, Analysis, and Issues for Congress.” CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 12 October 2004. http://assets.opencrs.com/rpts/RL32676_20041210.pdf (accessed 8 March 2012). The report describes NASA’s FY 2005 budget of US\$16.070 billion, a 4.5 percent increase over NASA’s FY 2004 appropriation of US\$15.378 billion. According to President George W. Bush’s Vision for Space Exploration, NASA will focus its activities on returning humans to the Moon by 2020 and someday sending them to Mars and to “worlds beyond.”
- Smith, Marcia S., and Daniel Morgan. “The National Aeronautics and Space Administration’s FY 2006 Budget Request: Description, Analysis, and Issues for Congress.” CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 17 November 2005. http://assets.opencrs.com/rpts/RL32988_20051117.pdf (accessed 8 March 2012). This report describes NASA’s FY 2006 budget and the congressional debate over NASA’s future programs. NASA requested US\$16.456 billion, 2.4 percent more than the US\$16.070 billion Congress appropriated in FY 2005. NASA Administrator Michael D. Griffin is accelerating development of a crew exploration vehicle.
- Smith, Marcia S., Daniel Morgan, and Wendy H. Schacht. “The National Aeronautics and Space Administration’s FY 2004 Budget Request: Description, Analysis, and Issues for Congress.” CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 23 September 2003. <http://assets.opencrs.com/rpts/>

- RL31821_20030923.pdf* (accessed 8 March 2012). This report discusses NASA's budget request of US\$15.469 billion for FY 2004, which is approximately 1 percent more than its FY 2003 appropriations level of US\$15.339 billion. NASA is making this budget request against the backdrop of the Space Shuttle *Columbia* tragedy, a context that could significantly influence NASA's appropriation.
- Trabucco, Peter. "What's Next for NASA After the Space Shuttle?" *Ad Astra*, Fall 2010. This article focuses on the state of the U.S. space program and the future of NASA. As a result of space program budget cuts, employees of NASA's Johnson Space Center could lose their jobs after the last Shuttle flight returns from space.
- U.S. Congress. Congressional Budget Office. *A Budgetary Analysis of NASA's New Vision for Space Exploration*. Report, Washington, DC, 2 September 2004. <http://www.cbo.gov/ftpdocs/57xx/doc5772/09-02-NASA.pdf> (accessed 8 March 2012). In this report analyzing NASA's budget request for FY 2005 and NASA's budget projections through 2020, the CBO assesses the implications of NASA's budget plans on the content and schedule of NASA's future activities, including the operation of the Space Shuttle and the United States' participation in the ISS. Funding would enable NASA to develop new vehicles for spaceflight, allowing humans to return to the Moon by 2020.
- U.S. Congress. Congressional Budget Office. *Alternatives for Future U.S. Space-Launch Capabilities*. Report, Washington, DC, October 2006. <http://www.cbo.gov/ftpdocs/76xx/doc7635/10-09-SpaceLaunch.pdf> (accessed 8 March 2012). NASA's plan to use piloted spacecraft to return to the Moon by 2020, pursuant to President George W. Bush's 2004 Vision for U.S. Space Exploration, could require the development of the capacity to launch payloads weighing more than 100 tonnes (110 tons). Currently, the payload capacity of launch vehicles does not exceed 25 tonnes (27.6 tons). This report evaluates the feasibility and cost of various alternatives that could significantly increase launch capability for piloted spaceflight beyond low Earth orbit.
- U.S. Congress. Congressional Budget Office. *Reinventing NASA*. Report, Washington, DC, 1 March 1994. <http://www.cbo.gov/ftpdocs/48xx/doc4893/doc20.pdf> (accessed 8 March 2012). This report examines NASA's two-pronged strategy to reinvent its program within the confines of a five-year budget plan that is approximately US\$25 billion lower than anticipated costs. The CBO also evaluates a set of alternatives that would focus NASA's program more tightly on one or another of its three major traditional objectives—piloted exploration of space, the generation of new scientific knowledge, or the development of space and aeronautical technology.
- U.S. Congress. House of Representatives. Committee on Science. *The Future of NASA*. 109th Cong., 1st sess., 28 June 2005. <http://www.gpo.gov/fdsys/pkg/CHRG-109hhr21949/pdf/CHRG-109hhr21949.pdf> (accessed 30 March 2012). NASA Administrator Michael D. Griffin is the sole witness at this hearing. His testimony concerns NASA's plans and priorities regarding the ISS, the Space Shuttles' return to flight, the Shuttles' planned retirement in 2010, and the development of crew exploration vehicles.

- U.S. Congress. House of Representatives. Committee on Science. *NASA's Fiscal Year 2004 Budget Request*. 108th Cong., 1st sess., 27 February 2003. <http://www.gpo.gov/fdsys/pkg/CHRG-108hhr85091/pdf/CHRG-108hhr85091.pdf> (accessed 30 March 2012). This hearing, which provides an overview of NASA's FY 2004 budget request, covers issues related to NASA's personnel management and its programs, including the status of the ISS and Space Shuttle programs.
- U.S. Congress. House of Representatives. Committee on Science. *NASA's Fiscal Year 2006 Budget Proposal*. 109th Cong., 1st sess., 17 February 2005. <http://www.gpo.gov/fdsys/pkg/CHRG-109hhr98564/html/CHRG-109hhr98564.htm> (accessed 30 March 2012). This hearing, which provides an overview of NASA's FY 2006 budget request, covers issues related to NASA programs, including the status of the ISS, the Space Shuttle, the HST, and the development of the crew exploration vehicle.
- U.S. Congress. House of Representatives. Committee on Science. *NASA's Fiscal Year 2007 Budget Proposal*. 109th Cong., 2nd sess., 16 February 2006. <http://www.gpo.gov/fdsys/pkg/CHRG-109hhr25937/pdf/CHRG-109hhr25937.pdf> (accessed 12 March 2012). This hearing presents an overview of NASA's FY 2007 budget request, covering issues related to NASA programs, including the status of the ISS, the Space Shuttle, and crew exploration vehicle programs.
- U.S. Congress. House of Representatives. Committee on Science. *Status of NASA's Programs*. 109th Cong., 1st sess., 3 November 2005. <http://www.gpo.gov/fdsys/pkg/CHRG-109hhr24151/pdf/CHRG-109hhr24151.pdf> (accessed 12 March 2012). This hearing provides an overview of NASA's approach to implementing the new Vision for Space Exploration and reviews issues related to NASA programs, including the status of the ISS, the Space Shuttle, and crew exploration vehicle programs.
- U.S. Congress. House of Representatives. Committee on Science. Subcommittee on Space and Aeronautics. *Determinations and Findings for the Space Shuttle Program*. 104th Cong., 1st sess., 30 November 1995. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest Congressional). This hearing examines NASA's decisions to suspend competitive bidding for Space Shuttle contracts and to negotiate a new contract for consolidating Space Shuttle operations under a single prime contractor, the United Space Alliance, a joint venture of Lockheed Martin and Rockwell International.
- U.S. Congress. House of Representatives. Committee on Science. Subcommittee on Space and Aeronautics. *Fiscal Year 1996 NASA Authorization*. 104th Cong., 1st sess., 13 February and 16 March 1995. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest Congressional). These hearings review cutbacks to NASA's budget and the effects of these decreases on program priorities. The hearings also provide an overview of Space Shuttle and ISS operations, including safety programs.
- U.S. Congress. House of Representatives. Committee on Science. Subcommittee on Space and Aeronautics. *Fiscal Year 1997 NASA Authorization*. 104th Cong., 2nd sess., 17 April 1996. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest

- Congressional). This hearing provides an overview of the FY 1997 budget for the Space Shuttle program and reviews the status of the space station and Shuttle programs. Testimony discusses negotiations between NASA and United Space Alliance regarding a contract for spaceflight operations for the Space Shuttle. The hearing also reviews aspects of NASA's safety programs involving the Shuttle.
- U.S. Congress. House of Representatives. Committee on Science. Subcommittee on Space and Aeronautics. *Fiscal Year 2001 NASA Authorization: NASA Posture, Parts I–VI*. 106th Cong., 2nd sess., 16 February, 16 and 22 March, 11 April, 10 May, and 13 September 2000. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest Congressional). This hearing presents NASA's FY 2001 budget request for human spaceflight, focusing on the ISS and Space Shuttle programs. Testimony reviews the findings of OPM's Office of the Inspector General, Office of Audits, which examined NASA human spaceflight programs, projects, and activities.
- U.S. Congress. House of Representatives. Committee on Science. Subcommittee on Space and Aeronautics. *NASA's Fiscal Year 1999 Budget Request, Parts I–IV*. 105th Cong., 2nd sess., 5–25 February and 19 March 1998. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest Congressional). This hearing presents NASA's FY 1999 budget request for human exploration and the development of the space enterprise, focusing on the priorities for and the costs of the ISS and Space Shuttle programs.
- U.S. Congress. House of Representatives. Committee on Science. Subcommittee on Space and Aeronautics. *Space Shuttle Program in Transition: Keeping Safety Paramount, Parts I and II*. 104th Cong., 1st sess., 27 September and 9 November 1995. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest Congressional). These hearings review NASA's policies for ensuring the flight safety of the Space Shuttle program in light of NASA's planned transfer of program operations to a single prime contractor.
- U.S. Congress. House of Representatives. Committee on Science. Subcommittee on Space and Aeronautics. *Space Shuttle Safety*. 105th Cong., 1st sess., 1 October 1997. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest Congressional). This hearing provides a justification for NASA's transfers of budgeted funds from the Space Shuttle program to its other programs; reviews the safety of the Shuttle program, including the effect of the transfer of funds on Shuttle safety; and presents views on Shuttle costs and improvements.
- U.S. Congress. House of Representatives. Committee on Science and Technology. *NASA's Fiscal Year 2008 Budget Request*. 110th Cong., 1st sess., 15 March 2007. http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_house_hearings&docid=f:33803.pdf (accessed 13 March 2012). This hearing, an overview of NASA's FY 2008 budget request, focuses on issues related to NASA programs, including the status of the ISS, the Space Shuttle, and crew exploration vehicle programs. The hearing also discusses concerns about potential funding shortfalls in NASA's FY 2008 budget request and the effect of these shortfalls on NASA programs.

- U.S. Congress. House of Representatives. Committee on Science and Technology. *NASA's Fiscal Year 2009 Budget Request*. 110th Cong., 2nd sess., 13 February 2008. <http://www.gpo.gov/fdsys/pkg/CHRG-110hhr40598/html/CHRG-110hhr40598.htm> (accessed 8 March 2012). This hearing, an overview of NASA's FY 2009 budget request, covers issues related to NASA programs, including the status of the ISS, the Space Shuttle, and exploration and research programs. The request includes US\$2.98 billion to operate and maintain NASA's three Space Shuttles.
- U.S. Congress. House of Representatives. Committee on Science and Technology. *NASA's Fiscal Year 2010 Budget Request*. 111th Cong., 1st sess., 19 May 2009. <http://www.gpo.gov/fdsys/pkg/CHRG-111hhr49551/pdf/CHRG-111hhr49551.pdf> (accessed 13 March 2012). This hearing, an overview of NASA's FY 2010 budget request, covers issues related to NASA programs, including the status of the ISS, the Space Shuttle, and exploration and research programs.
- U.S. Congress. House of Representatives. Committee on Science and Technology. *NASA's Fiscal Year 2011 Budget Request and Issues*. 111th Cong., 2nd sess., 25 February 2010. http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=111_house_hearings&docid=f:55837.pdf (accessed 8 March 2012). This hearing examines NASA's FY 2011 budget request, covering issues related to NASA programs, including the status of the ISS, the Space Shuttle, and exploration and research programs.
- U.S. Congress. House of Representatives. Committee on Science, Space, and Technology. Subcommittee on Space. *1992 NASA Authorization, Volume II*. 102nd Cong., 1st sess., 7 February–11 April 1991. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest Congressional). These hearings include a presentation of NASA's FY 1992 budget request for space transportation system programs, including the Space Shuttle and launch systems, and an explanation of the restructured ISS program.
- U.S. Congress. House of Representatives. Committee on Science, Space, and Technology. Subcommittee on Space. *1995 NASA Authorization*. 103rd Cong., 2nd sess., 23 February, 23 March, and 14 April 1994. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest Congressional). These hearings provide an explanation of NASA's FY 1995 budget request, focusing on efforts to maintain key program priorities in spite of budget cutbacks. The testimony includes an explanation of the budget request for human spaceflight programs, including the ISS and Space Shuttle.
- U.S. Congress. House of Representatives. Committee on Science, Space, and Technology. Subcommittee on Space. *Contract Management Issues: Cost Overruns on NASA's Shuttle Toilet*. 103rd Cong., 1st sess., 23 February 1993. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest Congressional). This hearing reviews the complexities and importance of developing a human waste collection system (WCS) for use on the Space Shuttle *Endeavour*, reviews NASA cost management operations regarding the Rockwell International Corporation contract, and provides an explanation for the wide discrepancy between the originally estimated cost and the actual cost of developing the WCS.

- U.S. Congress. Senate. Committee on Commerce, Science, and Transportation. Subcommittee on Science. *NASA's Fiscal Year 1992 Budget Overview*. 102nd Cong., 1st sess., 19 April 1991. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest Congressional). This hearing, an overview of the FY 1992 budget request for NASA, including funding for its space transportation and exploration programs, provides a perspective on NASA's priorities and concerns regarding the Space Shuttle and ISS programs.
- U.S. Congress. Senate. Committee on Commerce, Science, and Transportation. Subcommittee on Science and Space. *Human Spaceflight: The Space Shuttle and Beyond*. 109th Cong., 1st sess., 18 May 2005. <http://www.gpo.gov/fdsys/pkg/CHRG-109shrg25323/pdf/CHRG-109shrg25323.pdf> (accessed 30 March 2012). This hearing reviews Space Shuttle operations and future human spaceflight issues, including concerns for the safety and the value of the human spaceflight program. It also covers the planned retirement of the Shuttle fleet, NASA's transition to a new launch system, and the effect of these changes on NASA's workforce.
- U.S. Congress. Senate. Committee on Commerce, Science, and Transportation. Subcommittee on Science, Technology, and Space. *NASA Management Problems*. 106th Cong., 2nd sess., 22 March 2000. <http://www.gpo.gov/fdsys/pkg/CHRG-106shrg78634/pdf/CHRG-106shrg78634.pdf> (accessed 30 March 2012). In this hearing, which examines NASA's management problems and reform initiatives, NASA Administrator Daniel S. Goldin and others discuss the results of the Space Shuttle Independent Assessment Team's review of Space Shuttle subsystems and maintenance practices. The hearing also reviews the findings of the GAO's report assessing issues associated with the Space Shuttle program's civil service workforce.
- U.S. Congress. Senate. Committee on Commerce, Science, and Transportation. Subcommittee on Science, Technology, and Space. *NASA Space Shuttle and the Reusable Launch Vehicle Programs*. 104th Cong., 1st sess., 16 May 1995. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest Congressional). This hearing, an overview of the organization and policy of NASA's reusable space launch vehicle programs, reviews possibilities for restructuring and streamlining Space Shuttle program operations, such as placing greater reliance on contractors.
- U.S. Congress. Senate. Committee on Commerce, Science, and Transportation. Subcommittee on Science, Technology, and Space. *Shuttle Safety*. 107th Cong., 1st sess., 6 September 2001. <http://www.gpo.gov/fdsys/pkg/CHRG-107shrg82708/pdf/CHRG-107shrg82708.pdf> (accessed 30 March 2012). This hearing reviews NASA's efforts to implement Space Shuttle program safety and performance upgrades, specifically focusing on concerns about the effect of proposed budget cuts on NASA's ability to implement Space Shuttle safety upgrades and infrastructure improvements. The hearing also covers NASA's efforts to address workforce issues relating to the Space Shuttle program.

- U.S. Congress. Senate. Committee on Commerce, Science, and Transportation. Subcommittee on Science, Technology, and Space. *Space Station and Space Shuttle Programs*. 104th Cong., 2nd sess., 24 July 1996. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest Congressional). This hearing reviews the status of NASA's Space Shuttle and ISS programs, including issues involved in cost control and schedule management of the space station program.
- U.S. General Accounting Office. "Federal R&D Laboratories." Report no. GAO/RCED/NSIAD-96-78R, Washington, DC, October 29, 1996. <http://archive.gao.gov/papr2pdf/156329.pdf> (accessed 8 March 2012). This report provides FY 2005 operating budgets for Shuttle activities at NASA's Ames Research Center, Goddard Space Flight Center, Johnson Space Center, Kennedy Space Center, Langley Research Center, Lewis Research Center, Marshall Space Flight Center, and Stennis Space Center.
- U.S. General Accounting Office. "International Space Station and Shuttle Support Cost Limits." Briefing to Staff of the Senate Committee on Commerce, Science, and Transportation and House Committee on Science. Report no. GAO-04-648R, Washington, DC, 2 April 2004. <http://www.gao.gov/new.items/d04648r.pdf> (accessed 8 March 2012). This report analyzes issues relating to NASA's inadequate reporting of amounts obligated toward ISS and Space Shuttle spending, as required under the NASA Authorization Act of 2000, which limits NASA's spending on these programs.
- U.S. General Accounting Office. "Large Programs May Consume Increasing Share of Limited Future Budgets." Report no. GAO/NSIAD-92-278, Washington, DC, 9 April 1992. <http://archive.gao.gov/d35t11/147504.pdf> (accessed 8 March 2012). This report outlines Space Shuttle costs, including production and operation costs. The GAO recommends that, because the Space Shuttle program accounts for such a large portion of NASA's budget, Congress should consider directing NASA's Administrator to incorporate five-year program estimates and life-cycle costs into the funding section of NASA's biannual report on the project's status.
- U.S. General Accounting Office. "Major Management Challenges and Program Risks: National Aeronautics and Space Administration." Report no. GAO-01-258, Washington, DC, January 2001. <http://www.gao.gov/pas/2001/d01258.pdf> (accessed 8 March 2012). In this report, the GAO indicates that, since 1995, the Space Shuttle workforce has decreased by more than one-third. Many key areas of the program have insufficient qualified staff, and the workforce shows signs of overwork and fatigue. Moreover, the skill mix and demographics of the Shuttle workforce jeopardize NASA's ability to increase the Shuttle flight rate in support of the ISS's assembly and to transfer leadership roles to the next generation.
- U.S. General Accounting Office. "Major Management Challenges and Program Risks: National Aeronautics and Space Administration." Report no. GAO-03-114, Washington, DC, 1 January 2003. <http://www.gao.gov/new.items/d03114.pdf> (accessed 8 March 2012). This report focuses on management, oversight, and workforce issues facing NASA. According to the GAO, NASA needs to transform its long-standing business practices, enabling it to

strengthen its strategic human capital management, reduce space launch costs, and improve contract management.

- U.S. General Accounting Office. “NASA Budgets: Gap Between Funding Requirements and Projected Budgets Has Been Reopened.” Report no. GAO/NSIAD-95-155BR, Washington, DC, May 1995. <http://www.gao.gov/archive/1995/ns95155b.pdf> (accessed 8 March 2012). This report focuses on the discrepancy between NASA’s program plans and its likely budget. The projected gap for fiscal years 1996 through 2000 is US\$5.3 billion. When the GAO reported such a gap in 1992, NASA changed or deleted some of its major programs to help eliminate the discrepancy. However, those changes resulted in increased risks in several of its largest programs.
- U.S. General Accounting Office. “NASA: Compliance with Cost Limits Cannot Be Verified.” Report no. GAO-02-504R, Washington, DC, 10 April 2002. <http://www.gao.gov/new.items/d02504r.pdf> (accessed 8 March 2012). This report examines the congressionally imposed limits on NASA’s FY 2002 spending on ISS development and Space Shuttle flights. NASA has acknowledged that it lacks a modern, integrated financial management system capable of providing the detailed data needed to support amounts obligated against the limits.
- U.S. General Accounting Office. “NASA: International Space Station and Shuttle Support Cost Limits.” Report no. GAO-01-1000R, Washington, DC, 31 August 2001. <http://www.gao.gov/new.items/d011000r.pdf> (accessed 8 March 2012). This report analyzes NASA’s FY 2000 budget authorization. Because NASA was unable to furnish financial data in support of the actual cost to complete space station elements and subsystems, the GAO could not determine whether NASA’s costs were reasonable.
- U.S. General Accounting Office. “NASA Issues.” Report no. GAO/OCG-93-27TR, Washington, DC, 12 January 1992. <http://archive.gao.gov/d36t11/148271.pdf> (accessed 8 March 2012). This report claims that NASA’s strategic and program plans feature unrealistic funding levels and recommends that NASA improve operations management and oversight of its Space Shuttle program to enhance its efficiency and effectiveness.
- U.S. General Accounting Office. “Space Shuttle: Further Improvements Needed in NASA’s Modernization Efforts.” Report no. GAO-04-203, Washington, DC, 15 January 2004. <http://www.gao.gov/new.items/d04203.pdf> (accessed 8 March 2012). In this report, the GAO recommends that the NASA Administrator fully define the requirements for all elements of the Integrated Space Transportation Plan. Specifically, the report recommends that NASA and the ISS partners determine the ultimate life and mission of the space station, so that NASA will have a sound basis for fully defining Space Shuttle requirements.
- U.S. General Accounting Office. “Space Shuttle: Human Capital and Safety Upgrade Challenges Require Continued Attention.” Report no. GAO/NSIAD/GGD-00-186, Washington, DC, 15 August 2000. <http://www.gao.gov/archive/2000/n200186.pdf> (accessed 8 March 2012). This report discusses several internal NASA studies showing that downsizing has

harmed the Space Shuttle program's workforce, posing significant risks to Shuttle flight safety. Many key areas of the program have insufficient qualified staff, and the workforce shows signs of overwork and fatigue. Furthermore, the age of NASA's workforce—more than twice as many workers over the age of 60 as under the age of 30—jeopardizes NASA's ability to transfer leadership to the next generation.

- U.S. General Accounting Office. "Space Shuttle: Incomplete Data and Funding Approach Cost Risk for Upgrade Program." Report no. GAO/NSIAD-94-23, Washington, DC, 26 May 1994. <http://archive.gao.gov/t2pbat3/151985.pdf> (accessed 8 March 2012). This report indicates that NASA's budget cannot simultaneously support development of a new launch system and construction of the ISS. The report recommends that NASA's Administrator direct Space Shuttle program managers to estimate the life-cycle costs of proposed Shuttle upgrades.
- U.S. General Accounting Office. "Space Shuttle: NASA Must Reduce Costs Further To Operate Within Future Projected Funds." Report no. GAO/NSIAD-95-118, Washington, DC, June 1995. <http://archive.gao.gov/t2pbat1/154853.pdf> (accessed 8 March 2012). This report assesses Space Shuttle program cost reductions, past and future, and the effects of these reductions on safety. So far, NASA has reduced its cumulative funding for Shuttle operations by 22 percent, from FY 1992 to FY 1995, and its actual operating costs by 8.5 percent, between FY 1992 and 1994. The GAO report found that, although additional funding reductions are necessary to achieve NASA's future budget projections, NASA may not be able to reduce its costs without affecting safety.
- U.S. General Accounting Office. "Space Shuttle: NASA's Plans for Repairing or Replacing a Damaged or Destroyed Orbiter." Report no. GAO/NSIAD-94-197, Washington, DC, 21 July 1994. <http://archive.gao.gov/t2pbat2/152401.pdf> (accessed 8 March 2012). In this report, the GAO discusses NASA's lack of a contingency plan in the event that a Space Shuttle sustains damage. NASA has no capability to replace or repair a seriously damaged orbiter. NASA is terminating its structural spares program and intends to finish those parts that are 85 percent or more complete and to place them in storage. NASA does not believe this decision will significantly increase the risk to the Space Shuttle program.
- U.S. General Accounting Office. "Space Shuttle: Upgrade Activities and Carryover Balances." Report no. GAO/T-NSIAD-98-21, Washington, DC, 1 October 1997. <http://www.gao.gov/archive/1998/ns98021t.pdf> (accessed 8 March 2012). In this report, the GAO analyzes NASA's plan to take US\$190 million from the Space Shuttle program to help offset additional costs of the ISS. The GAO notes that the transfer of the funds to the ISS program does not adversely affect current or near-term Shuttle upgrade projects.
- U.S. General Accounting Office. "Space Station: Cost Control Difficulties Continue." Report no. GAO/NSIAD-96-135, Washington, DC, July 1996. <http://www.gao.gov/archive/1996/ns96135.pdf> (accessed 8 March 2012). This report describes cost overruns for the ISS. As of April 1996, the ISS was nearly US\$90 million over cost. The GAO warns that, if available resources prove inadequate, NASA will either have to exceed its annual funding

limitation on the ISS or defer or rephase other activities, potentially delaying the space station's construction schedule and increasing its overall cost.

U.S. General Accounting Office. "Space Transportation: The Content and Uses of Shuttle Cost Estimates." Report no. GAO/NSIAD-93-115, Washington, DC, 28 January 1993. <http://archive.gao.gov/d37t11/148584.pdf> (accessed 8 March 2012). This report describes costs associated with the operation of the Space Shuttle. The report notes that NASA's reported average cost per flight does not include some of the program's major costs, such as Shuttle development and future Shuttle upgrades.

U.S. Government Accountability Office. "International Space Station and Shuttle Support Cost Limits." Briefing to the Senate Committee on Commerce, Science, and Transportation and the House Committee on Science, Report no. GAO-05-492R, Washington, DC, 8 April 2005. <http://www.gao.gov/new.items/d05492r.pdf> (accessed 8 March 2012). This report examines whether NASA is fulfilling its accounting requirements according to the NASA Authorization Act of 2000. The Act requires that the GAO verify NASA's accounting for amounts obligated against established limits for the space station and related Space Shuttle support.

U.S. Government Accountability Office. "NASA: Long-Term Commitment to and Investment in Space Exploration Program Requires More Knowledge." Report no. GAO-06-817R, Washington, DC, 17 July 2006. <http://www.gao.gov/new.items/d06817r.pdf> (accessed 8 March 2012). This report reviews NASA's plans to spend nearly US\$230 billion over the next two decades to implement the President's Vision for Space Exploration. NASA continues to refine cost estimates for its exploration architecture but is unable to provide a firm estimate of the costs of implementation, mainly because the program is in its early stages.

Link to Part 1 (1970–1991), Chapter 14—Management and Funding of the Shuttle Program

CHAPTER 14—JUVENILE LITERATURE ABOUT THE SPACE SHUTTLE

- Adamson, Heather. *The Challenger Explosion*. Mankato, MN: Capstone Press, 2006. Ages 9–12. This graphic novel tells the story of Christa McAuliffe and the six other NASA astronauts who lost their lives in the Space Shuttle *Challenger* disaster on 28 January 1986.
- Amato, William. *The Space Shuttle (High-Tech Vehicles)*. New York: PowerKids Press, 2002. Ages 4–8. This book for school-age children shows how technologically advanced Space Shuttles are made and used, providing school an inside view of these high-powered, high-tech vehicles.
- Baker, David, and Heather Kisson. *The Shuttle*. New York: Weigl, 2009. Ages 4–8. This book, with its simple written text and a mixture of small color photos and artistic renditions of the Space Shuttle, describes the technology used to explore the universe.
- Bergin, Mark. *Space Shuttle*. New York: Franklin Watts, 1999. This book, recommended for elementary and junior high school readers, follows the development of the Space Shuttle program from the early years to the present day, covering construction of the Shuttle and missions in space, including takeoff, reentry, and landing.
- Blast Off! A Space Track Adventure*. Stamford, CT: Innovative Kids, 1999. This book features a windup toy Space Shuttle with its own built-in storage compartment, punch-out cardboard accessories, built-in tracks on every page, and a special foldout with almost two additional feet of track. The reader “rides” the toy Space Shuttle across space on track pages while reading about the universe.
- Branley, Franklyn Mansfield. *Floating in Space*. New York: HarperCollins, 1998. Ages 4–8. Grades K–2. The book, filled with kid-friendly diagrams and illustrations, describes life-support systems and weightlessness aboard the Space Shuttle, including descriptions of what astronauts eat, how they move, and what kinds of tasks they do in space.
- Bredeson, Carmen. *Astronauts*. New York: Children’s Press, 2003. This book introduces young readers to the work of astronauts, including special jobs they might have on the Space Shuttle and experiments they might perform in space.
- Bredeson, Carmen. *Getting Ready for Space*. New York: Children’s Press, 2003. This book provides a simple overview of the training that astronauts go through for missions on the Space Shuttle.
- Bredeson, Carmen. *John Glenn Returns to Orbit: Life on the Space Shuttle*. Berkeley Heights, NJ: Enslow Publishers, 2000. Ages 9 and older. This book describes the activities aboard Space Shuttle *Discovery* during its historic flight in 1998, when astronaut John H. Glenn Jr., the first American to orbit Earth, returned to space at the age of 77.
- Bredeson, Carmen. *Liftoff!* New York: Children’s Press, 2003. Ages 4–8. Grades K–2. This book shows the Shuttle being readied for flight and brought to the launchpad on the crawler.

The book features exciting text and photos and describes the difficulties of eating, drinking, and walking in space.

Bredeson, Carmen. *Living on a Space Shuttle*. New York: Children's Press, 2003. Grades K–2.

This book provides a simple description of how astronauts aboard a Space Shuttle perform everyday activities such as eating, drinking, and sleeping.

Bredeson, Carmen. *Shannon Lucid Space Ambassador*. Brookfield, CT: Millbrook Press, 1998.

<http://www.barnesandnoble.com/s/Shannon-Lucid-Space-Ambassador-?keyword=Shannon+Lucid+Space+Ambassador.&store=ebook> (accessed 8 March 2012). This electronic book chronicles the life of astronaut Shannon W. Lucid, from her childhood in Oklahoma, through her various Space Shuttle missions, to her six months aboard the *Mir* space station.

Bredeson, Carmen. *The Challenger Disaster: Tragic Space Flight*. Berkeley Heights, NJ:

Enslow Publishers, 1999. Ages 9–12. This book describes the events surrounding the explosion of Space Shuttle *Challenger* in 1986 and the investigation of the disaster, as well as the stories of the seven astronauts who died on the *Challenger*.

Campbell, Peter A. *Launch Day*. Brookfield, CT: Millbrook Press, 1995. Grades 3–6. This book

describes for young readers the preparation, launch, and return of a Space Shuttle *Atlantis* flight, describing the Vehicle Assembly Building and the Tractor-Transporter Vehicle, as the rocket is transported to the launchpad. The author includes many statistics to convey the complexity of a Shuttle liftoff, emphasizing the technological aspects of the flight, rather than life on board the Shuttle or the value of the mission.

Caper, William. *The Challenger Space Shuttle Explosion*. New York: Bearport, 2007. This book

examines the events surrounding the explosion of Space Shuttle *Challenger* and discusses the significant changes to the Space Shuttle program that resulted from the loss of *Challenger*.

Cole, Michael D. *The Columbia Space Shuttle Disaster: From First Liftoff to Tragic Final*

Flight. Rev. ed. Berkeley Heights, NJ: Enslow Publishers, 2003. This book contains technical details about the Space Shuttle, as well as personal information about the astronauts aboard *Columbia* on its final mission, STS-107. Photographs introduce young readers to the crew and help them understand the events that led to the tragic loss of the spacecraft and its crew.

Cole, Michael D. *Columbia: First Flight of the Space Shuttle*. Springfield, NJ: Enslow

Publishers, 1995. Grades 4–6. This book chronicles the first exciting flight of Space Shuttle *Columbia* in August 1981. The author also recounts some of the highlights of the United States' piloted spaceflight program.

Dahl, Michael, Alderman, Derrick, and Shea, Denise. *On the Launch Pad: A Counting Book*

About Rockets. Minneapolis, MN: Picture Window Books, 2004. Ages 3 and older. This

- book counts down from twelve to one as a Space Shuttle awaits liftoff. Readers are invited to find hidden numbers on an illustrated activity page.
- Davis, Amanda. *Spaceships*. New York: PowerKids Press, 1997. Ages 9–12. This book discusses various spacecraft, including rockets, satellites, and Space Shuttles, and the jobs that they perform.
- Fahey, Kathleen. *Challenger and Columbia*. Milwaukee, WI: Gareth Stevens Publishing, 2005. Ages 9 and older. The book describes the events leading up to the loss of Space Shuttles *Challenger* and *Columbia*. Based on detailed descriptions, expert testimony, and firsthand accounts, the author takes an in-depth look at the *Challenger* and *Columbia* tragedies and discusses the lessons learned from them.
- Feldman, Heather. *Columbia: The First Space Shuttle*. New York: PowerKids Press, 2003. Ages 9 and older. This book provides an excellent overview of the Space Shuttle program, from *Columbia*'s first mission to the aftermath of the *Challenger* tragedy, explaining how Space Shuttles work and describing the problems scientists encountered in developing the Shuttle.
- Follett Software Company and Amazing Media. *Space Shuttle*. Cupertino, CA: KidSoft, 1996. DVD. This DVD program contains a multimedia introduction to the Space Shuttle program, including descriptions of space vehicles, equipment, and crews; orientation and training at NASA's Johnson Space Center; and details of living and working in space on 53 NASA missions.
- Gardner, Charlie. *See How They Go: Spaceship*. London: Dorling Kindersley, 2009. This book introduces kids to vehicles that travel into space, from Moon rockets to Space Shuttles. The book contains dynamic images and simple text, as well as a sheet of stickers of featured vehicles.
- Gold, Susan Dudley. *To Space and Back: The Story of the Shuttle*. New York: Crestwood House, 1992. Ages 9–12. The author examines the history, uses, and accomplishments of the Space Shuttle program.
- Graham, Ian. *Space Travel*. New York: Dorling Kindersley, 2004. This book examines ways humans explore and live in space. The author includes sections on Space Shuttles, space stations, living in space, spacewalks, spacesuits, training for space, and science in space.
- Gross, Miriam J. *All About Space Shuttles*. New York: PowerKids Press, 2009. Ages 4–8. This book explains the history and function of Space Shuttles and how they have helped us reach outer space. Chapters cover Shuttle parts, liftoff, returning to Earth, and Space Shuttle uses.
- Hansen, Rosanna. *Liftoff! A Space Adventure*. Pleasantville, NY: Reader's Digest Children's Books, 2000. Ages 7–8. This book invites young readers to imagine blasting off into space aboard a Space Shuttle on a flight to help build a space station. The book describes experiencing G-forces when lifting off into space, how it feels to float in

microgravity while orbiting the Earth in a Shuttle, suiting up and going outside of the Shuttle to help build the space station, moving around with the help of a jetpack, eating a meal in space, and napping in a sleeping bag strapped to the wall of the crew quarters to prevent floating around.

Holden, Henry M. *The Tragedy of the Space Shuttle Challenger*. Berkeley Heights, NJ: MyReportLinks.com Books, 2004. Ages 9–12. This book describes events surrounding the explosion of Space Shuttle *Challenger* in 1986 and discusses the investigation of this disaster. The author tells the stories of the seven astronauts who died. The book also includes Internet links to related Web sites, source documents, and photographs.

Jackson, Francine. *Space Shuttle*. Outer Space Series. Danbury, CT: Grolier Educational, 1998. This book, written for a juvenile audience, describes the development of the Space Shuttle, its basic structure, and the daily life of astronauts aboard the Shuttle.

Kallen, Stuart A. *Space Shuttles*. Edina, MN: Abdo and Daughters, 1996. Ages 4–8. The author describes the Space Shuttles' physical characteristics and the lives and experiences of crew members while on board a Shuttle, as well as recounting the history of NASA's Space Shuttle program.

Kerrod, Robin. *Space Shuttles. The History of Space Exploration*. Milwaukee, WI: World Almanac Library, 2004. Ages 9–12. This book, which includes many full-page color photographs, describes three Space Shuttle missions that occurred in 1984.

Kettelkamp, Larry. *Living in Space*. New York: Morrow Junior Books, 1993. Ages 9–12. This book provides a brief history of U.S. space exploration before explaining how astronauts currently live and work in space and describing plans for piloted and unpiloted space exploration in the near future. Discussing spaceflights, Space Shuttles, and future plans for space stations, the author considers what humans have achieved toward living in space, as well as discussing hopes for the future.

Kortenkamp, Steve. *Space Shuttles*. Mankato, MN: Capstone Press, 2008. Ages 4–8. This book describes the history and uses of NASA's Space Shuttles, including both the practical uses and the drawbacks of reusable Space Shuttles. The author explains how the Shuttle flies and how it launches satellites. In addition, he describes how astronauts travel into space to make repairs on missions such as that to service the HST. The book also includes information about the two Shuttle disasters.

Langille, Jacqueline, and Bobbie Kalman. *The Space Shuttle*. New York: Crabtree Publishing, 1998. Ages 7–9. This book describes the construction and operation of NASA's Space Shuttle and the Shuttle's role in the future of humans in space, covering such topics as preparation for liftoff, living and working in space, and EVAs (spacewalks).

Lassieur, Allison. *The Space Shuttle*. New York: Children's Press, 2000. Ages 9–12. This book describes the beginnings of the Space Shuttle program and the role of the Shuttle in building a space station. The author covers such topics as the layout of a Shuttle, a day's

activities in space, and the *Challenger* disaster. The book includes a glossary and lists relevant books, organizations, and Internet sites.

- Lieurance, Suzanne. *The Space Shuttle Challenger Disaster in American History*. Berkeley Heights, NJ: Enslow Publishers, 2001. Ages 9–12. Grades 5–7. After recounting the events of the morning that Space Shuttle *Challenger* exploded, the author places the *Challenger*'s mission in historical context. She summarizes the U.S. space program up to that time, profiles each of the astronauts assigned to the *Challenger* crew, and discusses the selection and training of civilian teacher Christa McAuliffe for the mission.
- Littlejohn, Randy. *Life in Outer Space*. New York: Rosen Publishing Group, 2004. Ages 9–12. Grades 5–8. This book describes conditions for astronauts aboard Space Shuttles, space stations, and space capsules, explaining how humans survive in these extreme environments, and discusses possible future developments in space travel.
- Maynard, Christopher. *The Space Shuttle*. New York: Kingfisher Books, 1994. Ages 9–12. This fold-out book, which tells about a Space Shuttle mission to rescue a satellite, has flaps that open to reveal background information related to the story.
- McNeese, Tim. *The Challenger Disaster*. New York: Children's Press, 2003. This book documenting the *Challenger* disaster chronicles the failures on the part of NASA engineers to prevent the tragic accident and provides information about the mission and its crew members.
- Mullane, R. Mike. *Liftoff! An Astronaut's Dream*. Parsippany, NJ: Silver Burdett, 1995. The author, a former astronaut, describes his experiences in space and shares his ideas about the future of spaceflight.
- Murray, Peter. *The Space Shuttle*. Mankato, MN: Child's World, 1993. Ages 7–9. Grades 2–6. This book discusses the development and uses of reusable spacecraft, as well as describing the typical flight of a Space Shuttle. The book is also available in Spanish under the title *La Lanzadera Espacial*.
- NASA Aerospace Education Services Project. *Space Shuttle: Activities for Primary and Intermediate Students*. Cleveland, Ohio: Aerospace Education Services Project, Lewis Research Center, NASA, 1992. This book provides activities for primary and intermediate students. It was developed to help school teachers describe the Space Shuttle to students and explain how it operates.
- Oxlade, Chris. *Space Shuttle*. North Mankato, MN: Thameside Press, 2002. For infants and children of preschool age. This book describes how the different parts of a Space Shuttle fit together, how astronauts live and work in space, what the inside of a Space Shuttle looks like and how it works, and how the Shuttle's engines and booster rockets launch the Shuttle into space.

- Paul, Anthony, Belinda Grode Tatum, Lucious G. Tatum, Michael S. Emerson, and Pamela Geagan. *All About the Military/All About the Space Shuttle*. DVD. New York: GT Media, 2006. This DVD program intended for juveniles invites the viewer to imagine he or she is a new astronaut studying the history of space travel, learning about how and why NASA built the Space Shuttle, and exploring the universe. The viewer has the virtual experience of training to work, live, eat, and sleep in space, floating weightlessly in space, exploring all the decks of the Space Shuttle, and sitting in the seat of the Commander of the Shuttle on a mission to repair and return a satellite to Earth.
- Rees, Peter. *Secrets of the Space Shuttle*. New York: Children's Press, 2008. Ages 9–11. This book describes the space race, the first trip to the Moon, how Space Shuttles work, space stations, weightlessness, and what life is like for astronauts.
- Richardson, Adele. *Space Shuttle*. Mankato, MN: Smart Apple Media, 2000. Ages 4–8. This book examines the development of Space Shuttles, their components, and how humans have used them to explore outer space.
- Rouss, Sylvia A. *Reach for the Stars: A Little Torah's Journey*. New York: Devora Publishing, 2004. Grades 3–5. This is a true story of the miniature Torah that Israeli astronaut Ilan Ramon carried with him on Space Shuttle *Columbia's* mission, STS-107. This unique Torah survived the Holocaust, along with its guardian, Joachim Joseph. Years later, Ilan Ramon became close friends with Joachim Joseph, and agreed to take the Torah with him on his journey into space.
- Sexton, Colleen A. *Space Shuttles*. Minneapolis, MN: Bellwether Media, 2010. Ages 4–8. This book describes how Space Shuttles carry astronauts into space and return them to Earth. Readers learn the history of the Space Shuttle, the advanced technology on board a Shuttle, and how these space vehicles perform their missions.
- Shorto, Russell. *How To Fly the Space Shuttle*. Santa Fe, NM: John Muir Publications, 1992. Ages 9–12. This book explains to readers the basic principles that make spaceflight possible, as well as how Space Shuttles work and what astronauts do during a Shuttle mission.
- Sloan, Peter, and Sheryl Sloan. *The Space Shuttle*. Little Littleton, MA: Sundance, 2000. This beginning reader features photographs of Space Shuttles and of life in space aboard the Space Shuttle, accompanied by text using strong word-picture correlation, large print, word counts ranging from 31 to 46, and predictable language patterns.
- Software Toolworks and Follett Software Company. *The Software Toolworks Presents, Space Shuttle*. Computer game. Novato, CA: Software Toolworks, 1993. This child's game teaches users about the history of NASA and the Space Shuttle. Children playing the game make a virtual visit to Mission Control and take a virtual tour of the Space Shuttle. The game includes an experience of basic astronaut training, and players can select from several types of Shuttle mission, such as cleaning up space debris.

Space Shuttle: Find Out What's Inside. Sydney, NSW: Book Company Publishing, 2010. This “x-ray window” board book is intended for a juvenile audience. It contains pictures of the inside of a Space Shuttle and presents space travel facts.

Spangenburg, Ray, Diane Moser, and Kit Moser. *Onboard the Space Shuttle*. New York: Franklin Watts, 2002. Grades 5–9. The authors explain what life in space is like and describe the oddities that an aspiring astronaut must expect. Sections of the book cover the significant accomplishments of landmark Space Shuttle missions, such as the missions to repair the HST, as well as space stations and the *Challenger* explosion. The book also features many interesting color photographs and sidebars providing statistics, information about individual astronauts, and scientific principles related to space travel.

Steinberg, Florence S. *Aboard the Space Shuttle*. Washington, DC: NASA, 1980. This well-illustrated book is designed for classroom use. A good example of NASA’s public relations material, the book is intended to familiarize children with the Shuttle and its mission.

Stille, Darlene R. *Space Shuttle*. Minneapolis, MN: Compass Point Books, 2004. Ages 4–8. This book provides a simple introduction to the Space Shuttle, describing its equipment, parts, uses, and a typical journey into space.

Stott, Carole. *Fly the Space Shuttle*. New York: Dorling Kindersley, 2001. Ages 9 and older. In this book, aimed at a juvenile audience, the reader is invited to pretend that he or she is training as an astronaut to fly on a Space Shuttle mission. The reader is introduced to other members of the crew and learns about the fun and the difficulties of living in a weightless environment, maneuvering the Shuttle orbiter in space, and deploying a satellite. The book includes an easy-to-make, three-dimensional Space Shuttle model. Pull-out and lift-the-flap sections show how the Shuttle works and how it is used.

Streissguth, Thomas. *The Challenger: The Explosion on Liftoff*. Mankato, MN: Capstone High-Interest Books, 2003. Ages 9–12. This book examines Space Shuttle *Challenger* and the events that led to its destruction, along with the effects of the disaster on NASA’s space program.

Taylor, Robert. *Life Aboard the Space Shuttle*. San Diego, CA: Lucent Books, 2002. Ages 9–12. This book describes the early years of the Space Shuttle program, including the construction of the first Shuttles and the training of the crews. Chapters cover crew training, liftoff, adapting to microgravity, the problems of living in space, and how the Space Shuttle solves those problems.

Taylor, Robert. *The Space Shuttle*. San Diego, CA: Lucent Books, 2002. Ages 9–12. This book describes the history and development of the Space Shuttle, technological and political challenges to its development, and the future of the world’s first reusable space vehicle.

The Space Shuttle. Videocassette (VHS). Bethesda, MD: Discovery Channel Education, 2001.

This video, intended for elementary school children, looks behind the scenes at the construction and technology of the Space Shuttle and the people who make it possible.

The Space Shuttle. Videocassette (VHS). Bethesda, MD: Discovery Communications, 1996. This video, intended for grades 6–12, shows how NASA prepares the Space Shuttle for liftoff and how experiments carried out on board the Shuttle open new worlds of opportunity for scientific exploration.

Vogt, Gregory. *John Glenn's Return to Space*. Brookfield, CT: Millbrook Press, 2000. Grades 5–8. This book describes John H. Glenn Jr.'s early days as an astronaut and tells the story of his 1962 spaceflight in Friendship 7, as the first American to orbit Earth. The author recounts Glenn's return to space in 1998 at the age of 77 aboard Space Shuttle *Discovery*, emphasizing the extraordinary contrast between Glenn's first orbit around Earth and his recent Shuttle flight and using Glenn's story to symbolize the evolution of the American space program. The author also explains that Glenn joined the *Discovery* crew as a senior citizen so that he could participate in experiments aimed at measuring the effects of space travel on the human body.

Vogt, Gregory. *Space Shuttles*. Mankato, MN: Bridgestone Books, 1999. Ages 4–8. This book, full of fascinating NASA photographs to intrigue young readers, presents information about hands-on activities to promote interest in the Space Shuttle and space exploration. Labeled photodiagrams support technical vocabulary.

Walsh, Patricia, and Mark Adamic. *Space Vehicles*. Chicago: Heinemann Library, 2001. This book presents instructions for drawing the Space Shuttle, as well as other spacecraft and space vehicles, in six easy steps.

Whitehouse, Patricia. *Living in Space*. Chicago: Heinemann Library, 2004. Ages 4–8. Grades 1–3. This book gives readers a glimpse of the experiences astronauts have while living in space and on the Space Shuttle. It describes Shuttle astronauts' daily routines and explains how they receive air, water, and food, and reveals what happens to their garbage.

Whitehouse, Patricia. *Working in Space*. Chicago, IL: Heinemann Library, 2003. Ages 6 and up. This introduction to working in space discusses Space Shuttle astronaut training and different kinds of jobs in space, describing what it is like to leave Earth aboard a Space Shuttle, work in microgravity, fix satellites, work outside a Space Shuttle, and put on a spacesuit. The author also discusses what it might be like to work on other worlds. The book includes a section of space facts.

Zuehlke, Jeffrey. *The Space Shuttle*. Minneapolis, MN: Lerner, 2007. Ages 4–8. This book provides information on the Space Shuttles NASA has developed, explaining how NASA launches the Shuttle into orbit and how astronauts maneuver it in space.

[Link to Part 1 \(1970–1991\), Chapter 15—Juvenile Literature](#)

CHAPTER 15—COLUMBIA ACCIDENT AND AFTERMATH

Bea, Keith. “Disaster Relief and Responses: FY 2003 Supplemental Appropriations.” CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 25 August 2003. http://assets.opencrs.com/rpts/RL31999_20030825.pdf (accessed 11 March 2012). This report describes NASA’s request to Congress for US\$50 million to fund the investigation and recovery of debris from the *Columbia* disaster.

Boin, Arjen, and Paul Schulman. “Assessing NASA’s Safety Culture: The Limits and Possibilities of High-Reliability Theory.” *Public Administration Review* 68, no. 6 (November 2008): 1050–1062. This article reports the *Columbia* Accident Investigation Board’s (CAIB’s) sharp criticism of NASA’s safety culture. Adopting as a benchmark the concept of a “high-reliability organization,” the CAIB concluded that NASA does not possess the organizational characteristics that would have enabled it to prevent this disaster.

Cabbage, Michael and William Harwood. *Comm Check: The Final Flight of Shuttle Columbia*. New York: Free Press, 2004. Through dozens of interviews, documents, and recordings of meetings, veteran space journalists Cabbage and Harwood explore the political pressures and the management decisions that culminated in the *Columbia* accident. The authors tell the human story behind the tragic event, including the crucial errors that led to the accident and the events that unfolded in its immediate aftermath.

Chandler, David L. “Sifting Through the Clues; As the Evidence from *Columbia*’s Final Moments Piles Up, Investigators Are Faced with Several Competing Theories for What Triggered the Disaster.” *New Scientist*, 15 February 2003. This article describes the efforts underway to determine the causes of the *Columbia* tragedy. Investigators had not yet discovered the cause, and the author of the article believes that the likelihood of their quickly finding a definitive answer is remote.

Chandler, David L. “‘There Was Zero We Could Have Done . . .’; Or Was There? If NASA Had Known There Was No Prospect of *Columbia* Landing Safely, Could It Have Rescued the Crew?” *New Scientist*, 22 March 2003. This article reports that, shortly after *Columbia* broke up on reentry, Space Shuttle Program Manager Ronald D. Dittemore said that NASA had been aware that a piece of foam insulation had fallen from the Shuttle’s external tank during liftoff. In spite of this, NASA’s Mission Control decided not to photograph the orbiter’s underside to determine whether its heat-protection tiles were damaged. The article speculates about what NASA could have done to prevent the tragedy if it had discovered the damage before *Columbia*’s return to Earth.

Chien, Philip. *Columbia—Final Voyage: The Last Flight of NASA’s First Space Shuttle*. Chichester, UK: Praxis Publishing, 2006. This book explains STS-107, *Columbia*’s final mission, a “free flyer” mission in which NASA planned for the crew to spend 16 days in orbit, performing dozens of scientific experiments. The book devotes one chapter to each STS-107 astronaut. The author criticizes the media for covering the mission only after the catastrophe had occurred.

Cole, Michael D. *The Columbia Space Shuttle Disaster: From First Liftoff to Tragic Final Flight*. Rev. ed. Berkeley Heights, NJ: Enslow Publishers, 2003. This book contains technical details about the Space Shuttle, as well as personal information about the astronauts aboard *Columbia* on its final mission, STS-107. Photographs introduce young readers to the crew and help them understand the events that led to the tragic loss of the spacecraft and its crew.

Columbia Accident Investigation Board. *Report*. 6 vols. Washington, D.C.: Government Printing Office, 2003. <http://permanent.access.gpo.gov/lps39093/lps39093/caib.nasa.gov/news/report/volume5/default.html> (accessed 9 March 2012). The *Columbia* Accident Investigation Board (CAIB) wrote this report as a framework for national debate about the future of human spaceflight. The CAIB recommends expediting the replacement of the Space Shuttle, the primary means for transporting humans to and from Earth's orbit. In the final report, the Board makes 29 recommendations for NASA, including 15 that it considers essential prerequisites for the Shuttles' safe return to flight. The report also concludes that NASA lacks a strong safety culture.

"Columbia Investigation." *Spaceflight*, September 2003. This article describes ongoing efforts in the investigation of the Space Shuttle *Columbia* tragedy. The article notes that the *Columbia* Accident Investigation Board (CAIB) has delayed delivery of its accident report. The CAIB has warned NASA about potential problems with the bolts that connect the solid rocket boosters to the Space Shuttle's external tank, indicating that changes to the tanks will be necessary. In addition, the article predicts a radical reorganization of NASA's management.

Covault, Craig. "Columbia Probe Shifts." *Aviation Week & Space Technology*, 21 April 2003. The author of this article explains that the *Columbia* Accident Investigation Board (CAIB) is focusing on a possible scenario to explain the accident, in which a fracture of a wing T-seal opened a 1-inch-wide (0.6-centimeter-wide) vertical slit in the orbiter's leading edge. The Board is also examining the fracture of a reinforced-carbon-carbon panel.

Covault, Craig. "Columbia Revelations." *Aviation Week & Space Technology*, 3 March 2003. The author focuses on alarming e-mails among NASA engineers and contractor personnel in the days before *Columbia*'s disastrous reentry. The e-mail exchange provides deepening evidence that serious concerns at NASA about *Columbia*'s left wheel well and the survivability of its left wing were widespread and growing during the final days of the flight.

Covault, Craig. "Critical Columbia Tests." *Aviation Week & Space Technology*, 17 March 2003. This article describes efforts by the *Columbia* Accident Investigation Board (CAIB) and NASA to lead a critical series of debris-impact tests. The tests would help determine whether a large piece of external tank foam could have fatally damaged *Columbia* or whether other factors, such as materials degradation of the aging spacecraft, could have played a pivotal role in the tragedy.

- Covault, Craig. "Growing Evidence Points to Columbia Wing Breach." *Aviation Week & Space Technology*, 17 February 2003. This article reports on the growing evidence that wing failure played a large part in the *Columbia* disaster. The author points out that sensors in the wheel well and on the trailing edge of the wing provided some of the first signs of trouble.
- Covault, Craig. "NASA's Eroding Safety." *Aviation Week & Space Technology*, 12 May 2003. Covault predicts that the *Columbia* Accident Investigation Board's (CAIB's) report will cite serious deficiencies in NASA's overall safety program as a root cause or significant contributing factor to the loss of Space Shuttle *Columbia* and its crew. The author anticipates that the report will question whether NASA's oversight of the spacecraft was effective, once NASA had transferred specific duties of vehicle quality control to the United Space Alliance, as required under the Space Flight Operations Contract.
- Covault, Craig. "New Shuttle Concerns Aired." *Aviation Week & Space Technology*, 15 July 1996. The author reports that the White House, NASA, and the aerospace industry are assessing the effect of an independent Aerospace Safety Advisory Panel (ASAP) report that raises serious Space Shuttle safety issues, including the potential for increased risk of a Shuttle accident. The concerns stem from NASA's plan to reduce its costs by shifting additional operational responsibilities to the commercial contractor United Space Alliance. NASA and Thiokol are in the midst of a major investigation of the Space Shuttle's solid rocket motors to determine why hot gas penetrated into new areas of all six field joints on the two boosters that launched the orbiter *Columbia*.
- Covault, Craig. "Roaring Comeback." *Aviation Week & Space Technology*, 11 July 2005. This article discusses the Space Shuttle main engines (SSMEs) and solid rocket boosters (SRBs) that will propel *Discovery*'s launch into orbit on its return-to-flight mission. In the two years since the *Columbia* accident, NASA's SSME and SRB programs have substantially increased the rigor of their testing and quality oversight.
- Covault, Craig. "Rough Wing + Debris + A Fatal Combination?" *Aviation Week & Space Technology*, 24 February 2003. This article presents information about Shuttle *Columbia*'s left wing and the possibility that damage to the wing led to *Columbia*'s destruction. NASA's Johnson Space Center has documents from as early as 1988 indicating that wing roughness similar to that associated with *Columbia*'s left wing could result in a catastrophic burn-through when combined with potentially significant impact damage resembling the damage that occurred to the left wing in the 1 February reentry accident.
- Covault, Craig. "Shuttle Shaping Up; The Shuttle's Pace Toward Return-to-Flight Is Accelerating in Spite of Orbital Repair Challenges." *Aviation Week & Space Technology*, 13 December 2004. This article claims that, following the *Columbia* disaster, NASA may take as long as two years to build a fully certified thermal protection system and to develop the capability for in-orbit repair of the Shuttle *Columbia*'s wing leading edge. However, the safety tradeoffs are positive, overall, enabling return-to-flight preparations to accelerate this month and making a return of the Space Shuttle to space in the spring a real possibility.

- Covault, Craig. "Tank Debris Assessment Spotted 'No Safety Issue'." *Aviation Week & Space Technology*, 10 February 2003. This article describes the calculations performed by NASA and its contractors to assess the danger of damage to *Columbia* from foam falling from the external tank. The postlaunch analysis of *Columbia* determined that foam insulation debris posed no serious threat to the safety of the orbiter and crew.
- Covault, Craig. "USAF Imagery Confirms Columbia Wing Damaged." *Aviation Week & Space Technology*, 10 February 2003. This article describes images taken of *Columbia* as it approached Earth for the last time. The images show serious structural damage to the inboard leading edge of *Columbia*'s left wing. The author speculates about what the images can tell investigators about the accident.
- Cowen, Ron. "Columbia Disaster." *Science News*, 8 February 2003. The author claims that Space Shuttle *Columbia*, which broke apart on 1 February 2003 just minutes before it was scheduled to land, may have been doomed at liftoff. *Columbia* sustained damage during liftoff when foam detached from the Shuttle's external tanks and struck the orbiter's left wing.
- Deal, Duane W. "Beyond the Widget; Columbia Accident Lessons Affirmed." *Air & Space Power Journal* 18, no. 2 (22 June 2004): 31. According to the author of this article, the *Columbia* Accident Investigation Board (CAIB) has pointed out several lessons learned from the *Columbia* disaster, and senior leaders of other high-risk operations should seek to learn from the CAIB's conclusions. For example, managers of such operations should encourage dissenting opinions and should maintain checks and balances within their organizations.
- Evans, Ben. *Space Shuttle Columbia: Her Missions and Crews*. Chichester, UK: Praxis Publishing, 2005. This book, written by the scientists and researchers who developed and supported *Columbia*'s many payloads, the engineers who worked on the spacecraft, and the astronauts who flew it, comprises detailed descriptions of Space Shuttle *Columbia*'s 28 missions. The book is intended as a tribute to *Columbia* and to the people who have supported the Shuttle program.
- "Excerpts from Joint Congressional Hearing on Loss of Shuttle Columbia." *New York Times*, 13 February 2003. Witnesses testifying before a joint congressional hearing into the loss of Space Shuttle *Columbia* included NASA Administrator Sean O'Keefe, U.S. Senators Olympia J. Snowe (R-ME) and Clarence William "Bill" Nelson (D-FL), and U.S. Representative Sherwood Boehlert (R-NY).
- "Excerpts from NASA E-mails About Space Shuttle Before It Disintegrated." *New York Times*, 27 February 2003. This article contains excerpts from e-mail messages exchanged among engineers during Space Shuttle *Columbia*'s flight. NASA released these e-mails in February 2003.
- Fahey, Kathleen. *Challenger and Columbia*. Milwaukee, WI: Gareth Stevens Publishing, 2005. Ages 9 and older. The book describes the events leading up to the loss of Space Shuttles

Challenger and *Columbia*. Based on detailed descriptions, expert testimony, and firsthand accounts, the author takes an in-depth look at the *Challenger* and *Columbia* tragedies and discusses the lessons learned from them.

- Furniss, Tim. "Columbia Tragedy Piles Pressure on Space Program." *Spaceflight*, March 2003. This short news article describes how NASA reported to the media the sequence of events that occurred during Space Shuttle *Columbia*'s reentry. The article explains that *Columbia* was not equipped to perform a self-check for damage before returning to Earth.
- Furniss, Tim. "Investigators Close In on Causes of Columbia Loss." *Spaceflight*, May 2003. This article reviews the findings of the investigators regarding the *Columbia* accident. The author claims that investigators have identified the series of events that led to the disintegration of *Columbia*. The article reviews the possibility that the Shuttle's "black box" flight data recorder will shed light on the tragedy and discusses the efforts to retrieve Shuttle debris.
- Garrett, Terence M. "Whither Challenger, Wither Columbia." *American Review of Public Administration* 34, no. 4 (December 2004): 389–402. The *Columbia* Accident Investigation Board (CAIB) scrutinized similarities in NASA management's decision making in the ill-fated missions of Space Shuttles *Challenger* and *Columbia*, determining that NASA's organizational and management culture was a key factor in the loss of both orbiters. Both tragedies occurred after senior-level managers ignored advice from experts within the NASA organization. However, in this article, the author argues that NASA's management culture is not the sole cause of the tragedies, only a contributing factor.
- Geenty, John. "Flights of Fancy." *Spaceflight*, January 2005. This article describes how NASA planned its Space Shuttle missions before the *Columbia* tragedy. Originally, NASA had planned for the Shuttle to fly more often, with a greater range of payloads. However, the losses of *Challenger* and *Columbia* led to a change in Shuttle flights and schedules. Moreover, the loss of *Columbia* meant that future Shuttle missions would have to support the ISS, with no flights to spare for science programs.
- Hall, Joseph Lorenzo. "Columbia and Challenger: Organizational Failure at NASA." *Space Policy* 19, no. 4 (November 2003): 237–247. This article outlines some of the critical features of NASA's organization. The author discusses organizational change at NASA, namely "path dependence" and "normalization of deviance." He reviews the reasons that experts have called the *Challenger* tragedy an organizational failure. Finally, he argues that the recent *Columbia* accident also displays characteristics of organizational failure and proposes recommendations for the future.
- Hosenball, Mark, Jerry Adler, Anne Belli Gesalman, and Tamara Lipper. "Falling to Earth." *Newsweek*, 17 February 2003. This article describes the investigation into the explosion of *Columbia* and the Shuttle debris found throughout Texas and Louisiana. The author remarks that some journalists have denounced the administration of President George W. Bush for wasting money on showy but scientifically trivial unpiloted spaceflights, while

others have condemned the Bush administration for not spending enough. In addition, the author reports NASA engineers' ideas about what might have gone wrong on *Columbia*.

- Jenkins, Dennis R., and Jorge R. Frank. *Return to Flight Space Shuttle Discovery: Photo Scrapbook*. North Branch, MN: Specialty Press, 2006. This book shows photographs from the launch and flight of STS-114, the Space Shuttle program's return to flight following the *Columbia* disaster. This flight was the most photographed flight ever, with numerous cameras on ships, on aircraft, and on the ground tracking the vehicle during ascent, and the crew of the ISS taking a series of detailed photographs as *Discovery* approached the ISS. In addition, the crew of *Discovery* used cameras in the cockpit and on a long, robotic arm to examine almost every inch of *Discovery*.
- Klerkx, Greg. "It's Back . . . ; And This Time There Is More Than Ever Riding on the Space Shuttle's Success." *New Scientist*, 30 April 2005. This article describes NASA personnel's anticipation of the return to flight of Space Shuttle *Discovery* after the *Columbia* disaster. The article includes a checklist of the eight items—out of the list of the *Columbia* Accident Investigation Board's (CAIB's) 15 recommendations—that NASA completed before returning the Space Shuttle to flight.
- Klesius, Michael. "The Evolution of the Space Shuttle." *Air & Space*, July 2010. In this article, the author discusses the history of the Space Shuttle program, explores modifications to the design of the Space Shuttle considered throughout the program, and examines the errors leading to the loss of *Challenger* in January 1986 and *Columbia* in February 2003.
- Klotz, Irene. "Crunch Time for Shuttle As Safety Demands Pile Up." *New Scientist*, 15 July 2006. The author describes NASA's reactions to Space Shuttle *Discovery*'s return-to-flight mission. Instead of experiencing jubilation, NASA personnel are bracing for the effort they must make to complete the ISS before the Shuttle's retirement in 2010.
- Kluger, Jeffrey, Cathy Booth, Matthew Cooper, Sally B. Donnelly, Deborah Fowler, Hilary Hylton, Broward Liston, and David E. Thigpen. "Fragments of a Mystery." *Time*, 17 February 2003. The article reports that NASA investigators have determined that a loose chunk of insulating foam damaged Space Shuttle *Columbia*'s skin and led to its breakup in the skies over Texas during reentry. The authors found old NASA memoranda warning of the possibility of this type of accident.
- Kluger, Jeffrey, Stefano Coledan, Deborah Fowler, and Eric Roston. "Why NASA Can't Get It Right." *Time*, 1 August 2005. This article reports that four pieces of insulating foam—including one as large as a skateboard—have spun off Space Shuttle *Discovery*'s external fuel tank during liftoff. This is the same type of debris that damaged *Columbia*'s wing and doomed the craft. Photographs of the Shuttle have shown at least 25 dings in *Discovery*'s insulating tiles, including a 1.5-inch (3.8-centimeter) divot near the nose.
- Kortenkamp, Steve. *Space Shuttles*. Mankato, MN: Capstone Press, 2008. Ages 4–8. This book describes the history and uses of NASA's Space Shuttles, including both the practical uses and the drawbacks of reusable Space Shuttles. The author explains how the Shuttle

flies and how it launches satellites. In addition, he describes how astronauts travel into space to make repairs on missions such as the missions to service the HST. The book also includes information about the two Shuttle disasters.

- Kosova, Weston, Sam Seibert, Seth Mnookin, and Joshua Hammer. "The Right Stuff." *Newsweek*, 10 February 2003. This article profiles the astronauts who perished on *Columbia*: Richard D. Husband, William C. McCool, Michael P. Anderson, Kalpana Chawla, David M. Brown, Laurel B. Clark, and Ilan Ramon.
- Kruger, Jeffrey, Missy Adams, Cathy Booth-Thomas, John F. Dickerson, Sally Donnelly, Deborah Fowler, Greg Fulton, Jerry Hannifin, Eric Roston, Elaine Shannon, Mark Thompson, Karen Tumulty and Doug Waller.. "What Went Wrong?" *Time*, 28 July 2005. This article describes efforts to determine the cause of the explosion of Space Shuttle *Columbia* upon reentry to the Earth's atmosphere. The author explains how a Shuttle crew prepares for reentry and describes the items that the investigators will examine during the inquest into the *Columbia* accident.
- Lawler, Andrew. "Vision, Resources in Short Supply from Damaged U.S. Space Program." *Science* 301, no. 5638 (5 September 2003): 1300–1303. The author indicates that politicians in Washington, DC, need to respond to the *Columbia* Accident Investigation Board (CAIB) report issued on 26 August 2003 and to provide leadership. The author believes that the report compels Congress and the president to provide clearer vision and more substantial funding, to support a robust human space exploration program.
- Lerner, Preston. "NASA's Fixer-Upper Flies Again: Two Years After Columbia, NASA Is Counting on a Refurbished Space Shuttle To Revive Its Floundering Human-Spaceflight Program." *Popular Science*, May 2005. This article describes the May 2005 launch of STS-114, the return-to-flight Space Shuttle mission, using the refurbished Space Shuttle *Discovery*.
- "Lost in Space." *Economist*, 30 August 2003. This article focuses on key controversies surrounding the Space Shuttle *Columbia* accident. One of the more troubling issues discussed in the article is the possibility that another Shuttle—*Atlantis*—might have undertaken a rescue mission if the mission's managers had recognized that the foam had damaged *Columbia*.
- MacRae, Duncan. "Columbia Break-up Turns Focus on New-Generation RLV." *Interavia Business & Technology*, February 2003. This article describes the effect of the loss of *Columbia* on future Space Shuttle flights, providing details of the *Columbia* disaster. The author discusses the need to improve existing production capability, to enable the construction of additional space vehicles and the development of second-generation space vehicles.
- MacRae, Duncan. "Columbia Report Blasts NASA." *Interavia Business & Technology*, September 2003. This article reviews the official results of the investigation of the Space

Shuttle *Columbia* accident conducted by the *Columbia* Accident Investigation Board (CAIB), presenting the physical and organizational causes of the accident.

Martin, Ryan M, and Louis A. Boynton. "From Liftoff to Landing: NASA's Crisis Communications and Resulting Media Coverage Following the Challenger and Columbia Tragedies." *Public Relations Review* 31, no. 2 (June 2005): 253–261. NASA's public relations effort following the explosion of *Challenger* in 1986 is considered an example of crisis communications failure. However, after the *Columbia* disaster in 2003, NASA was praised for its successful handling of the crisis. Using widely accepted crisis communication concepts associated with stakeholder theory, the author discusses how four newspapers presented NASA's crisis communication efforts following the two crises, showing that the print media accorded NASA more positive coverage following the *Columbia* disaster than the *Challenger* disaster.

Morring, Frank, Jr. "Connecting the Dots." *Aviation Week & Space Technology*, 14 April 2003. This article examines NASA's efforts to correct the most likely cause of the *Columbia* tragedy before the *Columbia* Accident Investigation Board (CAIB) writes its report. NASA hopes to begin making corrections so that the Space Shuttles will be cleared to resume flights to the ISS as soon as possible. The article also notes the CAIB's efforts to recover *Columbia* debris and to use wind tunnel exercises to determine the cause of the tragedy.

Morring, Frank, Jr. "Shuttle Accident Puts 'Everything on Table'." *Aviation Week & Space Technology*, 10 February 2003. This article describes the efforts of Congress and the Bush administration to determine the cause of the *Columbia* accident. The congressional inquiry covered technical issues and political issues underlying space policy decisions on matters such as construction of the ISS, the need for RLVs, and funding to ensure Space Shuttle safety. The accident halted NASA's policy reviews regarding the final configuration of the ISS and plans to build an Orbital Space Plane.

Mowbray, Scott. "After Columbia: The ISS in Crisis." *Popular Science*, April 2003. This article focuses on how Space Shuttle *Columbia*'s accident has affected the construction of the ISS. The author explains that NASA had intended 2003—the year of the *Columbia* tragedy—as a pivotal year for building the space station. Instead, NASA will have to work with Russia's space authorities to ensure the safe operation of the ISS during the long grounding before another Shuttle is cleared to return to space.

Murnane, Andrew W. "Theft of Debris from the Space Shuttle Columbia: Criminal Penalties." CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 12 June 2003. <http://www.fas.org/spp/civil/crs/RS21417.pdf> (accessed 8 March 2012). This report explains why recovery of Space Shuttle *Columbia* debris was considered vital to the investigation into *Columbia*'s final moments of flight. The report also describes possible criminal penalties for theft of government property. According to the report, at least six individuals were indicted in Texas and Florida on charges that they stole *Columbia* debris.

- Murnane, Andrew W., and Daniel Inkelas. "Liability Issues Associated with the Space Shuttle Columbia Disaster." CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 12 February 2003. <http://www.fas.org/spp/civil/crs/RS21426.pdf> (accessed 8 March 2012). This report describes legal principles and processes that govern possible compensation for loss of life and property resulting from the Space Shuttle *Columbia* disaster.
- NASA. Johnson Space Center. *STS-107 Memories*. Washington, DC: U.S. Government Printing Office, 2006. CD. This CD, commemorating the seven crew members who lost their lives on Space Shuttle *Columbia* in February 2003, features biographies and photographs of the crew as they worked and trained together.
- NASA. Return to Flight Task Group. *Return to Flight Task Group—Final Report July 2005*. Washington, DC, 2005. http://www.nasa.gov/pdf/125343main_RTFTF_final_081705.pdf (accessed 8 March 2012). Soon after publication of the *Columbia* Accident Investigation Board (CAIB) report, NASA Administrator Sean O'Keefe appointed a Return to Flight (RTF) Task Group to assess NASA's progress implementing CAIB recommendations before resuming Shuttle flights. Relative to the 15 specific recommendations that the CAIB indicated should be implemented before returning to flight, NASA has met or exceeded 12. The remaining three recommendations were so challenging that NASA could not comply completely with the intent of the CAIB, but conducted extensive study, analyses, and hardware modifications that resulted in substantial progress toward making the vehicle safer.
- Oberg, James. "Puncture Repair Kit; The Shuttle Columbia Might Have Been Saved If the Crew Had Been Able To Fix A Hole While in Orbit." *New Scientist*, 15 November 2003. This article examines NASA's efforts to create patch kits that astronauts could use to make repairs to orbiters if they sustained damage such as *Columbia* experienced during its last takeoff. Besides trying out NASA's repair kit, the author identifies other options for inflight repairs to external surfaces of the spacecraft.
- Pianin, Eric, and Kathy Sawyer. "Skeptics Say Shuttle Worn Out, Obsolete." *Washington Post*, 12 May 2003. As NASA recovers from the *Columbia* disaster and works on returning the three remaining Space Shuttles to flight, a growing chorus of skeptics says that the 20-year-old spacecraft may have become unacceptably worn out and obsolete.
- Powell, Joel W. "Columbia Investigation: Piecing Together the Evidence." *Spaceflight*, October 2003. This article describes the efforts made to find clues among the debris from the *Columbia* tragedy. Investigators recovered the Orbiter Experiments recorder box and performed forensic analysis on the debris. The article contains photographs of the debris.
- "Radical Shuttle Changes in Light of Columbia Inquiry." *Spaceflight*, August 2003. This article predicts that the *Columbia* Accident Investigation Board (CAIB) will recommend changes to the Space Shuttle program. The article discusses the possibility that NASA could have launched Space Shuttle *Atlantis* to rescue the *Columbia* crew if NASA had

known of the impending dangers to *Columbia* of reentry. Changes to NASA's quality control and assurance programs and inspection programs may be required.

Reichhardt, Tony. "Columbia Explosion May Trigger Fatal Delays for Space Station." *Nature* 421, no. 6923 (6 February 2003): 561. This article focuses on the effect of Space Shuttle *Columbia*'s accident on the ISS program and on NASA's other projects.

Reichhardt, Tony. "NASA: Trawling Through the Wreckage." *Nature* 426, no. 6968 (18 December 2003): 754–755. This article reports on the causes of the accident that destroyed Space Shuttle *Columbia*. Results of the NASA investigation indicate that insulating foam could have punched a hole in the Shuttle.

Return to Flight Space Shuttle. Denver, CO: Denver Museum of Nature and Science, 2006. DVD. This DVD program describes NASA's efforts to prepare STS-114, the return-to-flight mission following the Space Shuttle *Columbia* disaster, as well as NASA's preparations for STS-121, which tested the safety and repair techniques imposed after the *Columbia* disaster.

Schuiling, Roelof. "STS-107: Columbia's Final Mission." *Spaceflight*, April 2003. This article discusses Space Shuttle *Columbia*'s final mission, STS-107, describing launch preparation, payloads, crew members, and daily activities during the 15-day mission to conduct scientific experiments. *Columbia* and its crew were lost during reentry over east Texas on 1 February 2003, at about 9:00 a.m. (EST).

Schwartz, John. "Shuttle Surface More Vulnerable Than Suspected." *New York Times*, 20 January 2005. In interviews this week, NASA officials reported the results of impact tests and analyses performed as part of the return-to-flight effort after the 2003 *Columbia* disaster. The tests showed that pieces of insulating foam weighing less than half an ounce could cause small cracks and damage to the surface coating on the heat-resistant panels on the leading edge of the wing.

Scott, William B. "Playing the Odds with Space Debris." *Aviation Week & Space Technology*, 17 February 2003. NASA investigation teams reassessed potential risks of orbital debris to Space Shuttle tiles and reinforced carbon-carbon leading edges after U.S. Air Force radar reported spotting an object after *Columbia* reached orbit. The report prompted renewed scrutiny of "space junk" and how it might have damaged the Shuttle's thermal protection system.

Seife, Charles. "Columbia Disaster Underscores the Risky Nature of Risk Analysis." *Science* 299, no. 5609 (14 February 2003): 1001. This article focuses on NASA's risk analysis of the probability of losing a Space Shuttle and its crew. The author believes that the use of probabilistic risk assessment (PRA) would improve NASA's risk analysis. PRA is a method engineers use to determine the likely failure rate of a complex system, such as a Space Shuttle, and to pinpoint the elements most likely to contribute to such a failure.

- Shiner, Linda. "The Space Shuttle Returns." *Air & Space*, May 2005. The author provides an update from NASA's Michoud Assembly Facility about construction of Space Shuttle *Discovery*. The article also describes the cause of the disintegration of Space Shuttle *Columbia* on 1 February 2003; results of the investigation conducted by engineers from NASA's Johnson Space Center in Houston, Texas, into the damaged panels of insulation; and reasons for the changes in the launch schedule of the Space Shuttle.
- Smith, Marcia S. "NASA's Space Shuttle Columbia: Quick Facts and Issues for Congress." CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 13 February 2003. http://assets.opencrs.com/rpts/RS21408_20030213.pdf (accessed 8 March 2012). This report includes facts about Space Shuttle *Columbia* and the investigation into the loss of *Columbia*, as well as a presentation to Congress about space program issues.
- Smith, Marcia S. "NASA's Space Shuttle Columbia: Synopsis of the Report of the *Columbia* Accident Investigation Board." CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 2 September 2003. http://assets.opencrs.com/rpts/RS21606_20030902.pdf (accessed 8 March 2012). This report presents a brief synopsis of the *Columbia* Accident Investigation Board's (CAIB's) report. The CAIB specified that 15 out of its 29 recommendations must be completed before the Shuttle's return to flight. The synopsis includes reasons for the accident, a discussion about whether NASA should have taken pictures of *Columbia* before its return to Earth, and speculation about whether NASA could have saved the crew.
- Smith, Marcia S. "NASA's Space Shuttle Program: Issues for Congress Related to the Columbia Tragedy and 'Return to Flight'." CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 2 June 2005. <http://fpc.state.gov/documents/organization/48804.pdf> (accessed 7 March 2012). This report describes Space Shuttle *Discovery*'s 9 August 2005 return-to-flight (RTF) mission, designated STS-114, the first Shuttle launch after the *Columbia* tragedy. On 27 July 2005, NASA announced that it planned to postpone indefinitely the second RTF mission, because a problem had occurred during *Discovery*'s launch that was similar to the event that led to the loss of *Columbia*.
- Smith, Marcia S. "NASA's Space Shuttle Program: The Columbia Tragedy, the Discovery Mission, and the Future of the Shuttle." CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 4 January 2006. <http://www.fas.org/sgp/crs/space/RS21408.pdf> (accessed 7 March 2012). This report describes the *Columbia* accident investigation and *Discovery*'s return-to-flight (RTF) mission, designated STS-114, and provides Congress with information about future Shuttle flights.
- Smith, Marcia S. "National Aeronautics and Space Administration: Overview, FY 2004 Budget in Brief, and Issues for Congress." CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 23 June 2003. http://assets.opencrs.com/rpts/RS21430_20030728.pdf (accessed 12 March 2012). This report focuses on NASA's US\$15.5 billion FY 2004 budget request. The author discusses the investigation of the

Space Shuttle *Columbia* tragedy on 1 February 2003 and its implications for NASA and for the space program as a whole.

- Smith, Marcia S., and Daniel Morgan. "The National Aeronautics and Space Administration: Overview, FY 2005 Budget in Brief, and Key Issues for Congress." CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 5 October 2004. <http://www.fas.org/spp/civil/crs/RS21744.pdf> (accessed 8 March 2012). This report describes NASA's FY 2005 budget request for US\$16.2 billion, a 5.6 percent increase over its FY 2004 appropriation of US\$15.4 billion. The report also discusses the new space exploration goals that President George W. Bush announced on 14 January 2004, NASA's plans to return the Space Shuttle to flight status following the Space Shuttle *Columbia* accident, and the health of NASA's aeronautics research program.
- Smith, R. Jeffrey, and Joe Stephens. "Safety an Issue Since '90s; Experts Critical of Shuttle Program's Budget Cuts." *Washington Post*, 3 February 2003. Despite the objections of many safety experts, NASA chose to reduce its costs by transforming the Space Shuttle program from a largely government-run effort to a program in which private contractors received more than 90 percent of its funds and operated under the supervision of only a few hundred full-time government employees. In the wake of Saturday's loss of one of the four Space Shuttles, *Columbia*, analysts are freshly scrutinizing NASA's decision.
- Space Shuttle a Remarkable Flying Machine*. Houston, Texas: TaLas Enterprises, 1994. Videocassette (VHS). This video profiles Space Shuttle *Columbia* from launch, to its activities in orbit, to landing. *Columbia* was the first reusable, fixed-wing spacecraft to go into orbit.
- "STS-107 Crew Profiles." *Spaceflight*, April 2003. This one-page article describes the seven crew members of STS-107, who perished in the *Columbia* tragedy, providing brief biographical information and a picture of each crew member.
- Tompkins, Phillip K. *Apollo, Challenger, Columbia: The Decline of the Space Program: A Study in Organizational Communication*. New York: Oxford University Press, 2004. This book portrays NASA from 1958 to 2003, concentrating on several specific points in the history of the space program, including 1986 and 2003, the periods surrounding the two Space Shuttle disasters. The author investigates the internal communication failures that resulted in the 1986 explosion of *Challenger* and the catastrophic failure of *Columbia* in 2003.
- U.S. Congress. House of Representatives. Committee on Science. *NASA's Response to the Columbia Report*. 108th Cong., 1st sess., 10 September 2003. <http://www.gpo.gov/fdsys/pkg/CHRG-108hhrg89217/pdf/CHRG-108hhrg89217.pdf> (accessed 30 March 2012). In testimony at this hearing, NASA Administrator Sean O'Keefe and *Columbia* Accident Investigation Board (CAIB) chair Harold W. Gehman Jr. review the CAIB report findings and recommendations on Space Shuttle *Columbia*'s 1 February 2003 accident and provide an overview of NASA's response to the report. The volume includes the text of NASA's Implementation Plan for Return to Flight and Beyond.

- U.S. Congress. House of Representatives. Committee on Science. Subcommittee on Space and Aeronautics. *Space Shuttle Safety*. 106th Cong., 1st sess., 23 September 1999. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest Congressional). Following the electrical wiring problems that occurred during the July 1999 mission of *Columbia*, STS-93, this hearing examines safety issues of the Space Shuttle program.
- U.S. Congress. Joint Hearing of the House Committee on Science, Subcommittee on Space and Aeronautics, and the Senate Committee on Commerce, Science, and Transportation. *Space Shuttle Columbia*. 108th Cong., 1st sess., 12 February 2003. <http://www.gpo.gov/fdsys/pkg/CHRG-108hhr85090/pdf/CHRG-108hhr85090.pdf> (accessed 30 March 2012). This joint hearing reviews the events surrounding the loss of Space Shuttle *Columbia* on 1 February 2003 and examines NASA's investigation into the accident.
- U.S. Congress. Senate. Committee on Commerce, Science, and Transportation. *NASA's Space Shuttle Program*. 108th Cong., 2nd sess., 8 September 2004. <http://www.gpo.gov/fdsys/pkg/CHRG-108shrg36172/pdf/CHRG-108shrg36172.pdf> (accessed 30 March 2012). This hearing examines the status of NASA's Space Shuttle program return-to-flight efforts in the aftermath of the loss of Space Shuttle *Columbia* on 1 February 2003 and assesses NASA's progress implementing the *Columbia* Accident Investigation Board's (CAIB's) recommendations in response to the accident.
- U.S. Government Accountability Office. "Maritime Security: Better Planning Needed To Help Ensure an Effective Port Security Assessment Program." Report no. GAO-04-1062, Washington, DC, September 2004. <http://www.gao.gov/new.items/d041062.pdf> (accessed 7 March 2012). This report about the Port Security Assessment Program includes a map of Texas showing the debris field from the *Columbia* disaster.
- Van der Haar, Gerard. "Columbia Inquiry." *Spaceflight*, April 2009. This article describing the inquiry into the Space Shuttle *Columbia* tragedy includes an image of *Columbia* taken from Kirtland Air Force Base, indicating a problem with the orbiter's left wing. The article describes NASA's accident reports and investigations and *Columbia* Accident Investigation Board (CAIB) activities.
- "Where Now for NASA?" *Nature* 421, no. 6923 (6 February 2003): 559. This article discusses the implications of the 2003 loss of Space Shuttle *Columbia* and its crew, offering an opinion about how the tragedy will affect other space exploration projects.
- White, Thomas Gordon, Jr. "The Establishment of Blame as a Framework for Sensemaking in the Space Policy Subsystem: A Study of the Apollo 1 and Challenger Accidents—OpenThesis." PhD Dissertation, Virginia Polytechnic Institute and State University, Blacksburg, VA, 2000. <http://www.openthesis.org/documents/Establishment-Blame-As-Framework-Sensemaking-582553.html> (accessed 8 March 2012). This dissertation investigates how the establishment of blame becomes a framework for sensemaking in a national policy subsystem. Using the Apollo 1 and Space Shuttle *Challenger*

accidents as case studies, the author examines the space policy subsystem's response to these two accidents and the process of establishing culpability.

See also Part 1 (1970–1991), Chapter 7—Challenger Accident and Aftermath

CHAPTER 16—THE SPACE SHUTTLE AND THE *MIR* SPACE STATION

Begley, Sharon, Ginny Carroll, Peter Katel, Catharine Skipp, and Peter Annin. "Down to Earth." *Newsweek*, 7 October 1996. This article profiles astronaut Shannon W. Lucid, examining her record 188 days in space (179 days aboard *Mir* and nine days total on Space Shuttle trips to and from *Mir*) and her health after returning to Earth in September 1996. The authors also discuss Lucid's education and her career background.

Bredeson, Carmen. *Shannon Lucid Space Ambassador*. Brookfield, CT: Millbrook Press, 1998. <http://www.barnesandnoble.com/s/Shannon-Lucid-Space-Ambassador-?keyword=Shannon+Lucid+Space+Ambassador.&store=ebook> (accessed 8 March 2012). This electronic book chronicles the life of astronaut Shannon W. Lucid, from her childhood in Oklahoma, through her various Space Shuttle missions, to her six months aboard the *Mir* space station.

Covault, Craig. "Shuttle Delay Forces Changes in U.S.-Russian Operations." *Aviation Week & Space Technology*, 22 July 1996. This article explores NASA's decision to delay the launch of STS-79 to *Mir* by six weeks because of problems with the Space Shuttles' solid rocket boosters, a decision that will affect Shuttle and *Mir* operations well into the following year. NASA had planned for U.S. astronaut Shannon W. Lucid, who is currently aboard *Mir*, to spend 4.5 months at the Russian space station, but this delay will force her to remain approximately six weeks longer than planned.

Cowen, Ron. "The International Approach." *Science News*, 20 May 1995. The author reviews the plans to link Space Shuttle *Atlantis* with the Russian space station *Mir*. This maneuver will lay the groundwork for construction of an international space station.

Foale, Colin. *Waystation to the Stars: The Story of Mir, Michael, and Me*. London: Headline Book Publishing, 2000. This book, written by the father of British-American astronaut C. Michael Foale, describes the astronaut's activities and experiences on *Mir* for five months in 1997. During his stay on *Mir*, Foale had to deal with fire, collision, and computer failure.

Kanas, Nick, Vyacheslav Salnitski, Ellen M. Grund, Vadim Gushin, Daniel S. Weiss, Olga Kozerenko, Alexander Sied, and Charles R. Marmar. "Social and Cultural Issues During Shuttle/*Mir* Space Missions." *Acta Astronautica* 47, no. 2–9 (November 2000): 647–655. This article summarizes the findings from a NASA-funded study conducted during several Shuttle-*Mir* space missions. The study related to social and cultural issues involving the American and Russian Shuttle and *Mir* crew and Mission Control staff.

Kidger, Neville. "STS-71 Preview." *Spaceflight*, June 1995. This article previews STS-71, the mission of Space Shuttle *Atlantis* to link up with *Mir*. The article discusses NASA's preparations for *Atlantis*'s mission, describes the Orbiter Docking System, and explains the docking maneuvers that *Atlantis* will undertake to link up with *Mir*.

- Lemonick, Michael, and Hannah Bloch. "Embrace in Space." *Time*, 10 July 1995. This article reports the docking of Space Shuttle *Atlantis* with the Russian space station *Mir*, orbiting 245 miles (394 kilometers) above Earth, discussing the goals of STS-71 and the political implications of the mission. The article also reviews the history of space cooperation between the United States and Russia since the end of the Cold War.
- Linenger, Jerry M. *Off the Planet: Surviving Five Perilous Months Aboard the Space Station Mir*. New York: McGraw-Hill, 2000. In this book, astronaut Jerry M. Linenger describes his background and his experience training for and living aboard *Mir*. Linenger recounts his efforts to survive 132 days aboard the decaying and unstable Russian space station *Mir*.
- Morgan, Clay. *Shuttle-Mir: The Illustrated History of the International Space Project*. Book and CD-ROM. NASA SP-2001-4230, Washington, DC, 2001. <http://history.nasa.gov/SP-4225/toc/toc-level1.htm> (accessed 8 March 2012). This book describes Space Shuttle missions to *Mir*, focusing on the people who lived and worked on the Russian space station. Sections of the book are devoted to training, operations, long-duration psychology, and bilingual issues. The book and accompanying CD are full of essays, diagrams, animations, and photographs of *Mir*. The CD contains information about science experiments conducted on the Space Shuttle and on *Mir*; a photo and video collection of Space Shuttle missions and Earth observations; images of mission patches; *High Above Earth*, a children's book; and NASA documents.
- Morgan, Clay. *Shuttle-Mir: The United States and Russia Share History's Highest Stage*. Book and CD-ROM. NASA History Series. NASA Report no. SP-2001-4225, Johnson Space Center, NASA, Houston, TX, 2001. <http://history.nasa.gov/SP-4225.pdf> (accessed 11 March 2012). This official NASA history of the 1995–1998 Shuttle-*Mir* program includes mission descriptions and summaries, a description of the support teams in Mission Control, photographs, and interviews. During this period, NASA's Space Shuttles ferried U.S. astronauts to *Mir* so that they could gain experience they would use to build and live on the ISS.
- Oberg, James E. "United We Orbit." *Air & Space*, January 1996. The author focuses on Space Shuttle *Atlantis*'s orbital hook-up with the Russian space station *Mir* in June 1995 during STS-71. Topics presented in the article include docking problems, docking mechanisms, design of both countries' probe-drogue systems (devices used to connect two spacecraft to one another), androgynous docking mechanisms, ring-to-ring systems, and remarks made by the crews.
- Schuiling, Roelof. "STS-60 Mission Report." *Spaceflight*, April 1994. This article describes STS-60, the first mission of the U.S.-Russian Shuttle-*Mir* program and the first Space Shuttle flight of a Russian cosmonaut, Sergei K. Krikalev. STS-60 carried into orbit the commercially developed Spacehab laboratory module and used it to conduct experiments in the Shuttle payload bay. The author describes crew members, daily activities, launch preparation, and payloads during the nine-day mission.

- Schuiling, Roelof. "STS-63 Mission Report." *Spaceflight*, May 1995. This article discusses STS-63, the second mission of the U.S.-Russian Shuttle-*Mir* program. In STS-63, *Discovery* carried out the first rendezvous of a U.S. Space Shuttle with Russia's space station *Mir*. Known as the Near-*Mir* mission, STS-63 carried into orbit Spacehab 3 and the Space Radar Laboratory (SRL). STS-63 was the first flight in which a woman—astronaut Eileen M. Collins—piloted the Shuttle, and the second Shuttle flight carrying a Russian cosmonaut—Vladimir G. Titov. The author describes the nine-day mission's crew members, daily activities, launch preparation, and payloads.
- Schuiling, Roelof. "STS-71 Mission Report." *Spaceflight*, October 1995. This article discusses STS-71, the mission of Space Shuttle *Atlantis* to dock with Russia's space station *Mir* and to carry out joint on-orbit operations. This mission was the first time that a U.S. Space Shuttle had docked at *Mir*. The author describes crew members, daily activities, launch preparation, and payloads during the 11-day mission.
- Schuiling, Roelof. "STS-74 Mission Report." *Spaceflight*, March 1996. This article discusses STS-74, the mission of Space Shuttle *Atlantis* to dock with Russia's space station *Mir* for the second time and to transfer equipment and supplies to *Mir*. The author describes crew members, daily activities, launch preparation, and payloads during the nine-day mission.
- Schuiling, Roelof. "STS-76 Mission Report." *Spaceflight*, July 1996. This article discusses STS-76, the mission of Space Shuttle *Atlantis* to dock with Russia's space station *Mir* for the third time and to deliver the first American female astronaut—Shannon W. Lucid—to live on *Mir*. The author describes crew members, daily activities, launch preparation, and payloads during the 10-day mission.
- Schuiling, Roelof. "STS-79 Mission Report." *Spaceflight*, February 1997. This article discusses STS-79, the mission of Space Shuttle *Atlantis* to dock with Russia's space station *Mir* for the fourth time. The Shuttle brought the Spacehab Double Module to support Shuttle-*Mir* activities. The author describes crew members, daily activities, launch preparation, and payloads during the 11-day mission.
- Schuiling, Roelof. "STS-81 Mission Report." *Spaceflight*, May 1997. This article discusses STS-81, the mission of Space Shuttle *Atlantis* to dock with Russia's space station *Mir* for the fifth time. The author describes crew members, daily activities, launch preparation, and payloads during the 18-day mission.
- Schuiling, Roelof. "STS-84 Mission Report." *Spaceflight*, September 1997. This article discusses STS-84, the mission of Space Shuttle *Atlantis* to dock with Russia's space station *Mir* for the sixth time. The author describes crew members, daily activities, launch preparation, and payloads during the nine-day mission.
- Schuiling, Roelof. "STS-86 Mission Report." *Spaceflight*, January 1998. This article discusses STS-86, the mission of Space Shuttle *Atlantis* to dock with Russia's space station *Mir* for the seventh time. The author describes crew members, daily activities, launch preparation, and payloads during the 10-day mission.

Schuiling, Roelof. “STS-89 Mission Report.” *Spaceflight*, June 1998. This article discusses STS-89, Space Shuttle *Endeavour*’s mission to dock with the Russian space station *Mir* to deliver scientific equipment, logistical hardware, and water. The author describes crew members, daily activities, launch preparation, and payloads during the eight-day mission.

Schuiling, Roelof. “STS-91 Mission Report.” *Spaceflight*, November 1998. This article discusses STS-91, Space Shuttle *Discovery*’s mission to dock with the Russian space station *Mir* and to deliver cargo, science experiments, and supplies. In addition, the crew moved long-term U.S. experiments that had been aboard *Mir* into *Discovery*’s mid-deck locker area. The author describes crew members, daily activities, launch preparation, and payloads during the nine-day mission.

U.S. General Accounting Office. “Former Soviet Union: Information on U.S. Bilateral Program Funding.” Report no. GAO/NSIAD-96-37, Washington, DC, 15 December 1995. <http://www.gao.gov/archive/1996/ns96037.pdf> (accessed 8 March 2012). Appendix II of this report lists financial obligations for Space Shuttle support missions with the Russian space program and *Mir*.

“USA, Russia Ink Mir Mission Agreement.” *Interavia Business & Technology*, December 1993. This article reviews plans to use U.S. Space Shuttles to supply a new space station, a joint project of the United States and Russia. Merging the U.S. Freedom program and the Russian *Mir-2* program, the two nations have agreed to design and build a space station together. NASA will need to cancel or reschedule other Shuttle missions to fly its Space Shuttles to the planned ISS.

Link to Part 1 (1970–1991), Chapter 13—The Shuttle in International Perspective

CHAPTER 17—THE SPACE SHUTTLE AND THE INTERNATIONAL SPACE STATION

“A Black Hole in the Sky.” *Economist*, 14 November 1998. NASA is upgrading the Space Shuttle fleet to enable the Shuttles to carry parts needed to build the ISS, thereby reducing the space station’s dependence on unpiloted Russian supply ships for refueling. NASA may delay essential repairs to the HST so that it can send additional Shuttle flights to help build the ISS.

Achenbach, Joel. “Retirement of Shuttles a Risk for Space Station, Critics Say.” *Washington Post*, 4 July 2011. This article reports that Christopher C. Kraft Jr., former Director of NASA’s Johnson Space Center, has cowritten a letter, endorsed by a number of NASA veterans and astronauts of the *Apollo* era, contending that the ISS will become more hazardous for astronauts without the availability of Space Shuttle resources for emergency backup.

“Another Node for the Space Station.” *Interavia Business & Technology*, Winter 2007. The article reports on the installation of the ISS’s Harmony Node 2, the interconnecting unit developed in Italy by Thales Alenia Space. Node 2, a crucial element for the development and completion of the orbital structure, will provide a passageway connecting the three science laboratories: the United States’ *Destiny*, Europe’s *Columbus*, and Japan’s *Kibo* modules.

Anselmo, Joseph C. “NASA Confident of Shuttle Backups.” *Aviation Week & Space Technology*, 8 April 1996. NASA has scheduled 26 Space Shuttle flights over the next four years, to enable assembly of the ISS. However, some observers are concerned that unanticipated problems could interfere with the Shuttle launch schedule, which is essential for the construction of the space station. Many key ISS components, such as the U.S. laboratory and habitation modules and connecting nodes, are designed specifically for the Shuttle’s payload bay, so grounding the Shuttle for any significant amount of time would delay space station assembly and provide ammunition to the ISS’s opponents in Congress.

Asker, James R. “Space Station Key to NASA’s Future.” *Aviation Week & Space Technology*, 15 March 1993. The author discusses NASA’s budgetary concerns, suggesting that NASA will have to make difficult choices about program priorities. He is concerned that, if NASA dedicates its budget to building a space station, it will have inadequate funds for other programs, including aeronautics, astronomy, and exploration. However, NASA Administrator Daniel S. Goldin envisions NASA launching six major scientific spacecraft and a new generation of smaller ones over several years, promoting interest in space sciences and engineering among graduate students, and fostering new enthusiasm for science and mathematics among school children.

Behrens, Carl E. “The International Space Station and the Space Shuttle.” CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 18 March 2009. <http://www.fas.org/sgp/crs/space/RL33568.pdf> (accessed 8 March 2012). This report details the developments, designs, costs, and schedules of the ISS, as well as

describing the future of the Space Shuttle and its future budgets. To conclude, the report outlines Space Shuttle issues for Congress to consider.

- Behrens, Carl, and Mary Beth Nitikin. "Extending NASA's Exemption from the Iran, North Korea, and Syria Nonproliferation Act." CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 1 October 2008. http://assets.opencrs.com/rpts/RL34477_20081001.pdf (accessed 8 March 2012). This report discusses the Iran Nonproliferation Act of 2000, enacted to prevent foreign transfers to Iran of weapons of mass destruction, missile technology, and advanced conventional weapons technology, particularly transfers from Russia. Section 6 of the Act bans U.S. payments to Russia in connection with the ISS unless the President of the United States determines that Russia is taking steps to prevent the proliferation of weapons to Iran.
- Covault, Craig. "Complex ISS Assembly Flight Poised for Liftoff." *Aviation Week & Space Technology*, 30 November 1998. The author claims that STS-80, the first Space Shuttle mission to assemble large elements of the ISS, will require precision flying, extensive robotics, and orbital construction, to join and outfit the station's initial U.S. and Russian modules. Shuttle astronauts will use the Canadian arm to lift the 15-by-33-foot (4.6-by-10-meter), 12.5-ton (11.3-tonne or 11,340-kilogram) Unity module out of the Shuttle's aft payload bay and affix it to the Russian Zarya spacecraft.
- Covault, Craig. "ISS Assembly Readied as Shuttle Pace Is Assessed." *Aviation Week & Space Technology*, 7 December 1998. The article discusses the ISS project, the largest international aerospace project ever undertaken, involving 16 nations and nearly 300 prime and subcontractors from around the world. The author argues that NASA will have difficulty meeting the schedule of three dozen Space Shuttle flights within the tight rendezvous launch windows required for ISS operations.
- Covault, Craig. "Station Commercialization Set as Assembly Flight Readied." *Aviation Week & Space Technology*, 30 November 1998. This article describes *Endeavour's* STS-88, the first Space Shuttle mission to assemble the initial elements of the ISS and discusses NASA's plan to turn the multibillion-dollar ISS into a commercial, fee-for-service facility. According to this scenario, private industry would assume substantial responsibility for the space station.
- Covault, Craig. "Station Training Focus: 'Building on the Fly.'" *Aviation Week & Space Technology*, 2 September 1996. This article describes astronaut and cosmonaut training for those who will build and live in the ISS. The author presents information about the Space Shuttle Training Facility at NASA's Johnson Space Center in Houston, Texas, and the Neutral Buoyancy Laboratory underwater training facility. He also explains EVA training requirements. In addition, the article discusses the costs of the ISS and its assembly schedule.
- Evans, Ben. "STS-92: The Builders Move into the ISS." *Spaceflight*, September 2000. This article describes STS-92, a mission in which Space Shuttle *Discovery* carried two new

modules to add to the ISS. *Discovery*'s crew installed the Z-1 truss, the first of 10 prefabricated sections of the gigantic Integrated Truss Segment.

Geenty, John. "Flights of Fancy." *Spaceflight*, January 2005. This article describes how NASA planned its Space Shuttle missions before the *Columbia* tragedy. Originally, NASA had planned for the Shuttle to fly more often, with a greater range of payloads. However, the losses of *Challenger* and *Columbia* led to a change in Shuttle flights and schedules. Moreover, the loss of *Columbia* meant that future Shuttle missions would have to support the ISS, with no flights to spare for science programs.

Hansen, Rosanna. *Liftoff! A Space Adventure*. Pleasantville, NY: Reader's Digest Children's Books, 2000. Ages 7–8. This book invites young readers to imagine blasting off into space aboard a Space Shuttle on a flight to help build a space station. The book describes experiencing G-forces when lifting off into space, how it feels to float in microgravity while orbiting the Earth in a Shuttle, suiting up and going outside of the Shuttle to help build the space station, moving around with the help of a jetpack, eating a meal in space, and napping in a sleeping bag strapped to the wall of the crew quarters to prevent floating around.

Jones, Thomas D. "The Future of NASA's Astronaut Corps." *Aerospace America*, October 2010. In this article, a former astronaut compares the number of astronauts at NASA when he flew his first Shuttle flight in 1994 with the number of astronauts that NASA will need after the Space Shuttles retire. Jones also discusses astronaut hiring and training for ISS missions.

Kidger, Neville. "STS-119: Orbital Operations." *Spaceflight*, May 2009. This article describes activities aboard the ISS, as well as summarizing STS-119, Space Shuttle *Discovery*'s mission to deliver solar arrays to the ISS. The article lists the Shuttle crew members and describes the crew's activities during the 12-day mission.

Kidger, Neville. "STS-120: Orbital Operations." *Spaceflight*, January 2008. This article describes activities aboard the ISS, as well as summarizing STS-120, Space Shuttle *Discovery*'s mission to deliver Harmony Node, a connecting module that will increase the orbiting laboratory's interior space. STS-120 crew also repaired the ISS's solar arrays. The article lists the STS-120 crew members and describes day-to-day operations during the 16-day mission.

Kidger, Neville. "STS-122: Orbital Operations." *Spaceflight*, April 2008. This article describes activities aboard the ISS, as well as summarizing STS-122, Space Shuttle *Atlantis*'s mission to deliver and to install the Columbus laboratory, the ISS module contributed by ESA. The article lists the STS-122 crew members and describes the crew's activities during the 13-day mission.

Kidger, Neville. "STS-123: Orbital Operations." *Spaceflight*, May 2008. This article describes activities aboard the ISS, as well as summarizing STS-123, Space Shuttle *Endeavour*'s mission to equip and supply the ISS. *Endeavour* delivered the Japanese Experiment

Logistics Module, which contains avionics and will serve as a storage area for experiment materials. The article, which also names STS-123 crew members and describes day-to-day operations during the 15-day mission, continues in the June 2008 edition of *Spaceflight*.

Kidger, Neville. "STS-123: Orbital Operations." *Spaceflight*, June 2008. This article continues an article in the May 2008 edition of *Spaceflight* summarizing STS-123, Space Shuttle *Endeavour*'s mission to equip and supply the ISS. *Endeavour* delivered the Japanese Experiment Logistics Module, which contains avionics and will serve as a storage area for experiment materials. The article lists STS-123 crew members and describes day-to-day operations during the 15-day mission.

Kidger, Neville. "STS-127: Orbital Operations." *Spaceflight*, October 2009. This article describes activities aboard the ISS, as well as summarizing STS-127, Space Shuttle *Endeavour*'s mission to deliver the Kibo Japanese Experiment Module Exposed Facility and Experiment Logistics Module Exposed Section. The article lists the Shuttle crew members and describes the crew's activities during the 15-day mission.

Kidger, Neville. "STS-128: Orbital Operations." *Spaceflight*, November 2009. This article describes activities aboard the ISS, as well as summarizing STS-128, Space Shuttle *Discovery*'s mission to deliver 7 tons (6.4 tonnes) of equipment and supplies to the ISS. After this mission, NASA will begin a transition from Shuttle missions to help build the ISS, to missions to use the ISS. The article lists crew members, recounts prelaunch activities, and describes activities during the 13-day mission.

Klotz, Irene. "Crunch Time for Shuttle as Safety Demands Pile Up." *New Scientist*, 15 July 2006. The author describes NASA's reactions to Space Shuttle *Discovery*'s STS-114 return-to-flight mission. Instead of experiencing jubilation, NASA personnel are bracing for the effort they must make to complete the ISS before the Shuttle's retirement in 2010.

Kremer, Ken. "STS-129: Shuttle Delivers Spares to ISS." *Spaceflight*, February 2010. This article describes STS-129, the mission of Space Shuttle *Atlantis* to equip and supply the ISS. The article lists crew members and daily activities during the 10-day mission.

Kremer, Ken. "STS-130: New Window on the World." *Spaceflight*, April 2010. This article describes STS-130, Space Shuttle *Endeavour*'s mission to deliver equipment and supplies to the ISS. The article describes prelaunch activities, crew members, and activities during the 13-day mission.

Kremer, Ken. "STS-131: Discovery's Penultimate Voyage." *Spaceflight*, June 2010. This article describes STS-131, in which Space Shuttle *Discovery* delivered 8 tons (7.3 tonnes) of equipment and supplies to the ISS. The article describes prelaunch activities, crew members, and day-to-day operations during the 15-day mission.

Kremer, Ken. "STS-132: Atlantis' Last Blast with Russian Beauty." *Spaceflight*, August 2010. This article describes STS-132, Space Shuttle *Atlantis*'s final mission before its

- retirement. The goal of STS-132 was to equip and supply the ISS. Besides carrying spare parts to the ISS, *Atlantis* delivered the 11,000-pound (4,989.5-kilogram) Russian Rassvet Mini Research Module, which will enable ISS crew to conduct biotechnology and fluid physics experiments. The article describes prelaunch activities, crew members, payloads, and daily operations during the 11-day mission.
- Kremer, Ken, and Gerard van de Haar. "STS-133: Discovery's Final Voyage into Orbit." *Spaceflight*, May 2011. This article describes STS-133, Space Shuttle *Discovery*'s mission to deliver spare parts to the ISS. The article describes prelaunch activities, crew members, and activities during the 12-day mission. Space Shuttle *Discovery* retired after completing this mission.
- Lawler, Andrew. "NASA May Cut Shuttle Flights and Reduce Science on Station." *Science* 309, no. 5734 (22 July 2005): 540–541. This article focuses on NASA's plan to curtail Space Shuttle flights and to reduce science research activities on the ISS.
- Lawler, Andrew, Daniel Clery, and Dennis Normile. "Life Science Research on Space Station Is Headed for Big Cuts." *Science* 308, no. 5722 (29 April 2005): 610–611. The authors report that NASA is finalizing a new plan to reduce the quality and quantity of cutting-edge research on the ISS. The cost of returning the Space Shuttle to flight, finishing the ISS by 2010, and building new launchers will have a negative effect on continuing high-priority research in biology at the space station.
- Leary, Warren E. "Shuttle To Put European Module in Space." *New York Times*, 5 December 2007. Space Shuttle *Atlantis* is poised for a 6 December 2007 launch to the ISS on an 11-day mission that will make the orbital outpost more international. The principal goal of the mission, STS-117, is to add ESA's new Columbus laboratory to the growing station.
- Logsdon, John M. "Lessons To Be Learned from Space Station Saga." *Aviation Week & Space Technology*, 7 March 1994. The author claims that, in 1983, when President Ronald W. Reagan ordered NASA to build a space station, European nations also declared their intention to build a space station. Yet, 10 years later, neither the United States nor Europe has followed through. The author suggests that the lack of powerful supporters for the project and disagreement about the value of building a space station have thwarted these plans.
- McElroy, John H. "Some Thoughts on Space Station Science." *Space Policy* 17, no. 4 (November 2001): 257–260. The author comments that ISS budget cuts negatively affect U.S. scientific capabilities and undermine the United States' investment in the Space Shuttle.
- Morring, Frank, Jr. "Commercial Break; NASA Plans COTS-Only Approach for ISS, Dropping Russia's Progress." *Aviation Week & Space Technology*, 21 April 2008. This article reports that NASA officials will discuss with Congress a plan for NASA to continue using Russia's Soyuz crew launch vehicles to transport astronauts to and from the ISS after the final Space Shuttle flight in 2010. NASA does not intend to continue using

Russian Progress vehicles for U.S. cargo resupply but plans to use its own Commercial Orbital Transportation System (COTS) program vehicles, which are as yet untested.

Morring, Frank, Jr. “End Game; Space Station Managers Tread Tricky Path to Completion with 10 Shuttle Flights Left.” *Aviation Week & Space Technology*, 31 March 2008. This article describes the remaining scheduled Space Shuttle missions to build the ISS. The Shuttles will deliver spare parts so that they will be available on the ISS when original hardware wears out. The author notes that NASA is still having difficulty incorporating the required safety modifications to the foam-covered external tanks that carry propellants for Shuttle launches.

Morring, Frank, Jr. “Finishing the Job; Long-Planned Station-Assembly Finale Promises To Be a Nail-Biter for Crews.” *Aviation Week & Space Technology*, 21 August 2006. The author of this article reports that NASA astronauts, engineers, and controllers intend to try to double the size of the ISS by adding as many as five pressurized modules and three more large solar arrays to power them. Transporting and installing the equipment will require more than 16 flights over four years and the labor of crews from Canada, Europe, Japan, Russia, and the United States. The Space Shuttle is the only spacecraft able to transport the large components of the ISS, which were custom-built for its cargo bay.

Morring, Frank, Jr. “One More Time; Hubble Program Planning Final Shuttle Mission as Early as 2007 To Maintain the Observatory.” *Aviation Week & Space Technology*, 11 July 2005. This article describes NASA’s decision to approve a Shuttle mission to repair the HST. The author also discusses NASA’s efforts to schedule a realistic number of Shuttle flights to enable the ISS partners to complete assembly of the space station before the Shuttle’s planned retirement at the end of 2010.

Morring, Frank, Jr. “Shuttle Accident Puts ‘Everything on Table’.” *Aviation Week & Space Technology*, 10 February 2003. This article describes the efforts of Congress and the presidential administration to determine the cause of the *Columbia* accident. The congressional inquiry covered technical issues and political issues underlying space policy decisions on matters such as construction of the ISS, the need for RLVs, and funding to ensure Space Shuttle safety. The accident halted NASA’s policy reviews regarding the final configuration of the ISS and plans to build an Orbital Space Plane.

Mowbray, Scott. “After Columbia: The ISS in Crisis.” *Popular Science*, April 2003. This article focuses on how Space Shuttle *Columbia*’s accident has affected the construction of the ISS. The author explains that NASA had intended 2003—the year of the *Columbia* tragedy—as a pivotal year for building the space station. Instead, NASA will have to work with Russia’s space authorities to ensure the safe operations of the ISS during the long grounding before another Shuttle is cleared to return to space.

“New ISS Plan Based on 16 Shuttle Flights.” *Interavia Business & Technology*, Spring 2006. This article reports that the heads of the national space agencies collaborating on the ISS have announced the planned sequence of spaceflights to assemble the new space station. The agencies intend to use the space transportation systems of Europe, Japan, Russia, and

the United States to ensure full use of the ISS. Besides using U.S. and Russian spacecraft to transport cargo to the ISS, the partners will use the European automated cargo vehicle, which is scheduled for launch on an Ariane rocket in the spring of 2007. The U.S. Space Shuttle will make a series of 16 flights to carry Japan's experiment module Kibo and Europe's Columbus laboratory to the space station.

Reichhardt, Tony. "Columbia Explosion May Trigger Fatal Delays for Space Station." *Nature* 421, no. 6923 (6 February 2003): 561. This article focuses on the effect of Space Shuttle *Columbia's* accident on the ISS program and on NASA's other projects.

Reichhardt, Tony. "Researchers Find Silver Lining in Delay To Work on Space Station." *Nature* 386, no. 6626 (17 April 1997): 633. This article describes the reaction to NASA's decision to delay the construction of the ISS. The good news for NASA is that the announced 11-month delay will give NASA time to conduct additional Space Shuttle research missions.

Reichhardt, Tony. "Shuttlenauts: The Faces of the Space Shuttle Era." *Air & Space*, January 2011. The author discusses the Shuttle's role in the construction of the ISS and examines the careers of several astronauts who spent time on the Space Shuttle, including former Navy pilot Robert L. Crippen and Shuttle Commander Peggy A. Whitson.

Reuters. "Panel Agrees To Protect Jobs, Add Mission for Space Shuttle." *Washington Post*, 16 July 2010. Reuters reports that the Senate Commerce, Science, and Transportation Committee has unanimously passed a plan to postpone retirement of the Space Shuttle. In addition, the committee has agreed to include in NASA's three-year spending plan an additional Space Shuttle mission to the ISS.

Schuiling, Roelof. "STS-88: 'Unity' Module Delivered to Space Station." *Spaceflight*, March 1999. This article discusses STS-88, Space Shuttle *Endeavour's* mission to begin construction of the ISS. The author describes crew members, daily activities, launch preparation, and payloads during the 13-day mission.

Schuiling, Roelof. "STS-92: Discovery Completes 100th Shuttle Flight." *Spaceflight*, January 2001. This article describes STS-92, Space Shuttle *Discovery's* mission to continue the construction of the ISS. The article describes launch preparation, payloads, crew members, and daily activities during the 14-day mission.

Schuiling, Roelof. "STS-96: Discovery Shuttle Launched on First Mission of 1999." *Spaceflight*, October 1999. This article discusses STS-96, Space Shuttle *Discovery's* mission to deliver parts and materials to the ISS. The author describes crew members, day-to-day operations, launch preparation, and payloads during the nine-day mission.

Schuiling, Roelof. "STS-97: Endeavour Delivers Solar Arrays to ISS." *Spaceflight*, March 2001. This article discusses STS-97, Space Shuttle *Endeavour's* mission to deliver solar arrays and supplies to the ISS. The author describes crew members, daily activities, launch preparation, and payloads during the 12-day mission.

- Schuiling, Roelof. "STS-98: Atlantis Carries Destiny to Orbit." *Spaceflight*, May 2001. This article describes STS-98, the mission of Space Shuttle *Atlantis* to take the United States' laboratory Destiny to the ISS. The article names the crew and describes their activities for each of the 14 days the Shuttle was in space.
- Schuiling, Roelof. "STS-100: Endeavour Carries Robotic Components to ISS." *Spaceflight*, August 2001. This article discusses STS-100, Space Shuttle *Endeavour*'s mission to equip and supply the ISS. The author describes crew members, daily activities, launch preparation, and payloads during the 13-day mission.
- Schuiling, Roelof. "STS-101: Maintenance Mission to Unity-Zarya." *Spaceflight*, August 2000. This article describes STS-101, the mission of Space Shuttle *Atlantis* to maintain the Unity-Zarya ISS. Unity and Zarya were the first ISS components. The article describes launch preparation, payloads, crew members, and activities during the 11-day mission.
- Schuiling, Roelof. "STS-104: Atlantis Delivers Space Doorway to ISS." *Spaceflight*, October 2001. This article describes STS-104, the mission of Space Shuttle *Atlantis* to deliver and install a space doorway on the ISS. The article describes launch preparation, payloads, crew members, and activities during the 14-day mission.
- Schuiling, Roelof. "STS-105: Space Shuttle Mission Report." *Spaceflight*, November 2001. This article describes STS-105, Space Shuttle *Discovery*'s mission to equip and supply the ISS. The article describes launch preparation, payloads, crew members, and daily activities during the 13-day mission.
- Schuiling, Roelof. "STS-106: Atlantis Revisits Space Station." *Spaceflight*, December 2000. This article describes STS-106, the mission of Space Shuttle *Atlantis* to equip the ISS and prepare the station for its first crew. The article describes launch preparation, payloads, crew members, and activities during the 13-day mission.
- Schuiling, Roelof. "STS-108: Endeavour Carries Fourth Crew to Space Station." *Spaceflight*, March 2002. This article discusses STS-108, Space Shuttle *Endeavour*'s mission to equip and supply the ISS. The author describes crew members, daily activities, launch preparation, and payloads during the 13-day mission.
- Schuiling, Roelof. "STS-111: Weather Delays Endeavour's Launch and Landing." *Spaceflight*, September 2002. This article discusses STS-111, Space Shuttle *Endeavour*'s mission to equip and supply the ISS. The author describes crew members, daily activities, launch preparation, and payloads during the 15-day mission.
- Schuiling, Roelof. "STS-112: Advances Space Station Assembly." *Spaceflight*, January 2003. This article describes STS-112, the mission of Space Shuttle *Atlantis* to deliver to the ISS the S1 integrated truss segment and spacewalk platform and to install the new components. The article describes launch preparation, payloads, crew members, and activities during the 12-day mission.

- Schuiling, Roelof. "STS-113: Endeavour Overcomes Technical Hitches To Deliver Sixth ISS Crew." *Spaceflight*, March 2003. This article discusses STS-113, Space Shuttle *Endeavor*'s mission to equip and supply the ISS. The author describes crew members, daily activities, launch preparation, and payloads during the 15-day mission.
- Shayler, David J. *Walking in Space*. New York: Springer-Praxis, 2004. This book provides a comprehensive overview and analysis of the techniques astronauts use in EVAs (spacewalks). The author draws on original documentation and on personal interviews with astronauts who have EVA experience, as well as on the accounts of staff involved in spacesuit design, EVA planning, and operations. The book describes the development of techniques for ensuring crew safety during spacewalks and looks ahead to future EVAs from the ISS and the development of new technology.
- Sietzen, Frank, Jr. "The Future of Space Transportation: Is It Expendable? Reusables? Or the Shuttle? Why Not All Three?" *Ad Astra*, August 2002. This short article discusses the future of the Space Shuttle and Congress's failure to increase NASA's budget, despite rising ISS costs.
- Simpson, Clive. "STS-114: Return of the Space Shuttle." *Spaceflight*, October 2005. This article discusses STS-114, Space Shuttle *Discovery*'s mission to deliver equipment and supplies to the ISS. The author describes crew members, daily activities, launch preparation, and payloads during the 13-day mission.
- Simpson, Clive. "STS-115: Astronauts Complete Tough Mission." *Spaceflight*, November 2006. This article discusses STS-115, the mission of Space Shuttle *Atlantis* to deliver to the ISS the P3/P4 integrated truss and to install the truss and a pair of solar arrays on the ISS. The author describes crew members, daily activities, launch preparation, and payloads during the 11-day mission.
- Simpson, Clive. "STS-117: Atlantis Completes Spectacular Mission." *Spaceflight*, August 2007. This article discusses STS-117, the mission of Space Shuttle *Atlantis* to deliver to the ISS and to install the second and third starboard truss segments S3/S4 and another pair of solar arrays. The author describes crew members, daily activities, launch preparation, and payloads during the 17-day mission.
- Simpson, Clive, and Gerard van der Haar. "STS-122: Columbus Ushers in a New Space Era." *Spaceflight*, April 2008. The authors of this article describe STS-122, Space Shuttle *Atlantis*'s mission to carry the Columbus laboratory to the ISS. The crew of the ISS took three spacewalks to prepare the 21-ton (19.05-tonne) Columbus laboratory for scientific work. The authors describe crew activities over the 13 days the Shuttle was in space.
- Simpson, Clive, and Tim Furniss. "STS-121: Harmony Launch Starts Busy Period for Europe." *Spaceflight*, December 2007. This article describes *Discovery*'s STS-121 mission to carry to the ISS the Harmony node, a passageway connecting the three ISS science laboratories. The article describes crew activities over the 14 days that the Shuttle was in space.

- Simpson, Clive, Gerard van der Haar, and Rudolf van Beest. "STS-116: Shuttle Mission Re-Wires ISS." *Spaceflight*, February 2007. This article discusses STS-116, Space Shuttle *Discovery*'s mission to deliver equipment and supplies to the ISS. The author describes crew members, daily activities, launch preparation, and payloads during the 12-day mission.
- Simpson, Clive, Gerard van der Haar, and Rudolf van Beest. "STS-118: Endeavour Finally Returns to Space." *Spaceflight*, October 2007. This article discusses STS-118, Space Shuttle *Endeavour*'s mission to deliver equipment and supplies to the ISS. The crew delivered and installed a third starboard truss segment and 5,000 pounds (2,268 kilograms) of equipment and supplies. The author describes crew members, daily activities, launch preparation, and payloads during the 12-day mission.
- Smith, Marcia S. "Space Stations." CRS Issue Brief for Congress, Congressional Research Service, Library of Congress, Washington, DC, 4 January 2006. http://assets.opencrs.com/rpts/IB93017_20060104.pdf (accessed 7 March 2012). This report discusses developments, designs, costs, and schedules of the ISS, as well as the future of the Space Shuttle and its future budgets. The author also reports related congressional actions of FY 2005 and FY 2006. In addition, the report discusses the space station's international partners, including Canada, Europe, and Japan, and examines the risks and benefits of partnering with Russia.
- Smith, Marcia S., Daniel Morgan, and Wendy H. Schacht. "The National Aeronautics and Space Administration's FY 2004 Budget Request: Description, Analysis, and Issues for Congress." CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 23 September 2003. http://assets.opencrs.com/rpts/RL31821_20030923.pdf (accessed 8 March 2012). This report discusses NASA's budget request of US\$15.469 billion for FY 2004. NASA is making this budget request against the backdrop of the Space Shuttle *Columbia* tragedy, a context that could significantly influence NASA's appropriation. Other NASA budget issues include funding for the ISS program, Project Prometheus, aeronautics, and technology transfer.
- U.S. Congress. Congressional Budget Office. "A Budgetary Analysis of NASA's New Vision for Space Exploration." Report, Washington, DC, 2 September 2004. <http://www.cbo.gov/ftpdocs/57xx/doc5772/09-02-NASA.pdf> (accessed 8 March 2012). This report provides an analysis of NASA's budget request for FY 2005, as well as an analysis of NASA's budget projection, which forecasts budgetary requirements through 2020. In its analysis, the CBO assesses the implications of NASA's budget plans for the content and schedule of NASA's future activities, including the operation of the Space Shuttle and the United States' participation in the ISS.
- U.S. Congress. House of Representatives. Committee on Science. *NASA's Fiscal Year 2007 Budget Proposal*. 109th Cong., 2nd sess., 16 February 2006. <http://www.gpo.gov/fdsys/pkg/CHRG-109hrg25937/pdf/CHRG-109hrg25937.pdf> (accessed 12 March 2012). This hearing presents an overview of NASA's FY 2007 budget request, covering issues related to NASA programs, including the status of the ISS, the Space Shuttle, and crew exploration vehicle programs.

- U.S. Congress. House of Representatives. Committee on Science. *Status of NASA's Programs*. 109th Cong., 1st sess., 3 November 2005. <http://www.gpo.gov/fdsys/pkg/CHRG-109hhr24151/pdf/CHRG-109hhr24151.pdf> (accessed 12 March 2012). This hearing provides an overview of NASA's approach to implementing the President's New Vision for Space Exploration. The hearing reviews issues related to NASA programs, including the status of the ISS, the Space Shuttle, and crew exploration vehicle programs.
- U.S. Congress. House of Representatives. Committee on Science. *The Status of Russian Participation in the International Space Station Program*. 105th Cong., 1st sess., 2 February 1997. <http://www.gpo.gov/fdsys/pkg/CHRG-105hhr38882/pdf/CHRG-105hhr38882.pdf> (accessed 10 April 2012). This hearing focuses on congressional oversight of the ISS, Russia's difficulties meeting its commitments to the ISS, and the effect of Russia's difficulties on U.S. efforts to support the space station.
- U.S. Congress. House of Representatives. Committee on Science. *U.S.-Japanese Cooperation in Human Spaceflight*. 104th Cong., 1st sess., 19 October 1995. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest Congressional). This hearing provides background on U.S.-Japanese cooperative space programs, including the status of these programs and the outlook for their future. Specifics of Japanese participation in ISS scientific experiments are also included.
- U.S. Congress. House of Representatives. Committee on Science. *U.S.-Russian Cooperation in Human Spaceflight*. 105th Cong., 1st sess., 18 September 1997 and 6 May, 24 June, 5 August, and 7 October 1998. <http://catalog.gpo.gov/fdlpdir/locate.jsp?ItemNumber=1025-A-01&SYS=000502274> (accessed 11 November 2011). These hearings review the status of NASA's ISS program, focusing on problems related to Russian Government participation in the ISS program, including the inability to meet funding obligations.
- U.S. Congress. House of Representatives. Committee on Science and Technology. *NASA's Fiscal Year 2008 Budget Request*. 110th Cong., 1st sess., 15 March 2007. http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_house_hearings&docid=f:33803.pdf (accessed 13 March 2012). This hearing, an overview of NASA's FY 2008 budget request, focuses on issues related to NASA programs, including the status of the ISS, the Space Shuttle, and crew exploration vehicle programs. The hearing also discusses concerns about potential funding shortfalls in NASA's FY 2008 budget request and the effect of these shortfalls on NASA programs.
- U.S. Congress. House of Representatives. Committee on Science and Technology. *NASA's Fiscal Year 2009 Budget Request*. 110th Cong., 2nd sess., 13 February 2008. <http://www.gpo.gov/fdsys/pkg/CHRG-110hhr40598/html/CHRG-110hhr40598.htm> (accessed 8 March 2012). This hearing, an overview of NASA's FY 2009 budget request, covers issues related to NASA programs, including the status of the ISS, the Space Shuttle, and exploration and research programs. The request includes US\$2.98 billion to operate and maintain NASA's three Space Shuttles.

- U.S. Congress. House of Representatives. Committee on Science and Technology. *NASA's Fiscal Year 2010 Budget Request*. 111th Cong., 1st sess., 19 May 2009. <http://www.gpo.gov/fdsys/pkg/CHRG-111hhr49551/pdf/CHRG-111hhr49551.pdf> (accessed 13 March 2012). This hearing, an overview of NASA's FY 2010 budget request, covers issues related to NASA programs, including the status of the ISS, the Space Shuttle, and exploration and research programs.
- U.S. Congress. House of Representatives. Committee on Science and Technology. *NASA's Fiscal Year 2011 Budget Request and Issues*. 111th Cong., 2nd sess., 25 February 2010. http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=111_house_hearings&docid=f:55837.pdf (accessed 8 March 2012). This hearing examines NASA's FY 2011 budget request, covering issues related to NASA programs, including the status of the ISS, the Space Shuttle, and exploration and research programs.
- U.S. Congress. House of Representatives. Committee on Science and Technology. Subcommittee on Space and Aeronautics. *NASA's International Space Station Program: Status and Issues*. 110th Cong., 2nd sess., 24 April 2008. <http://www.gpo.gov/fdsys/pkg/CHRG-110hhr41799/pdf/CHRG-110hhr41799.pdf> (accessed 7 March 2012). This hearing examines the challenges and risks facing the ISS program in light of the decision to retire the Space Shuttle in 2010.
- U.S. Congress. House of Representatives. Committee on Science and Technology. Subcommittee on Space and Aeronautics. *NASA's Space Shuttle and International Space Station Programs: Status and Issues*. 110th Cong., 1st sess., 24 July 2007. <http://www.gpo.gov/fdsys/pkg/CHRG-110hhr36737/html/CHRG-110hhr36737.htm> (accessed 14 March 2012). This hearing examines the main challenges to NASA's accomplishing its major goals—to continue successfully flying the Space Shuttle until its planned retirement in 2010 and to complete the planned Shuttle mission to service the HST. This hearing also considers the obstacles to completing the assembly of the ISS by the time NASA retires the Space Shuttle.
- U.S. Congress. House of Representatives. Committee on Science, Space, and Technology. Subcommittee on Space. *1993 NASA Authorization, Volume II*. 102nd Cong., 2nd sess., 19 February–5 March 1992. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest Congressional). These hearings provide highlights of the 22 January 1992 Space Shuttle mission, STS-42, a mission focusing on scientific experiments. They also review the status and accomplishments of the ISS program and provide an overview of Space Shuttle programs, focusing on cost-reduction issues and the proposed cancellation of the advanced solid rocket motor program.
- U.S. Congress. Senate. Committee on Commerce, Science, and Transportation. Subcommittee on Science and Space. *Assessing Commercial Space Capabilities*. 111th Cong., 2nd sess., 18 March 2010. http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=111_senate_hearings&docid=f:66983.pdf (accessed 14 March 2012). This hearing examines commercial space capabilities and developments in light of the President George W. Bush administration's decision to discontinue the Space Shuttle program in favor of

expanded commercial-sector contracting, under NASA oversight, for transportation of astronauts to the ISS and for further exploration.

- U.S. Congress. Senate. Committee on Commerce, Science, and Transportation. Subcommittee on Space, Aeronautics, and Related Sciences. *Issues Facing the U.S. Space Program After Retirement of the Space Shuttle*. 110th Cong., 1st sess., 15 November 2007. In this hearing, NASA witnesses discuss various aspects of the U.S. space program after NASA retires the Space Shuttle, including the status of space transportation in support of the ISS.
- U.S. General Accounting Office. “International Space Station: U.S. Life-Cycle Funding Requirements.” Report no. GAO/NSIAD-98-147, Washington, DC, May 1998. <http://www.gao.gov/archive/1998/ns98147.pdf> (accessed 7 March 2012). This report on the ISS includes information about the cost of Shuttle flights and their effect on the cost of the space station. The GAO finds that, without the offsetting reduction in Shuttle support costs, the overall costs of the space station would have been significantly higher.
- U.S. General Accounting Office. “Major Management Challenges and Program Risks: National Aeronautics and Space Administration.” Report no. GAO-01-258, Washington, DC, January 2001. <http://www.gao.gov/pas/2001/d01258.pdf> (accessed 8 March 2012). This report indicates that, since 1995, the Shuttle workforce has decreased by more than one-third. Several internal NASA studies have shown that the reduction has negatively affected the Space Shuttle program’s workforce. Many key program areas have insufficient qualified staff, and the remaining staff shows signs of overwork and fatigue. Moreover, the skill mix and demographics of the Shuttle workforce jeopardize NASA’s ability to increase the Shuttle flight rate in support of the ISS’s assembly and to transfer leadership roles to the next generation.
- U.S. General Accounting Office. “NASA: Shuttle Fleet’s Safe Return to Flight Is Key to Space Station Progress.” Report no. GAO-04-201T, Washington, DC, 29 October 2003. <http://www.gao.gov/new.items/d04201t.pdf> (accessed 7 March 2012). This report addresses concern over the cost and assembly schedule for the ISS after NASA grounded Space Shuttle flights following the *Columbia* accident. The report also discusses the implications of the Shuttle fleet’s grounding on the schedule and cost of building the ISS and on the ISS partners’ funding and agreements.
- U.S. General Accounting Office. “Space Shuttle: Declining Budget and Tight Schedule Could Jeopardize Space Station Support.” Report no. GAO/NSIAD-95-171, Washington, DC, 28 July 1995. <http://www.gao.gov/archive/1995/ns95171.pdf> (accessed 8 March 2012). This report reviews NASA’s efforts to redesign the lift capability of the Space Shuttle so that it will be able to make the 21 flights necessary to complete the assembly of the ISS within five years. The GAO found that NASA’s plans for increasing the Shuttle’s lift capability are complex, involving approximately 30 individual actions, such as hardware redesigns, improved flight-design techniques, and new operational procedures.
- U.S. General Accounting Office. “Space Shuttle: NASA Must Reduce Costs Further To Operate Within Future Projected Funds.” Report no. GAO/NSIAD-95-118, Washington, DC, June

1995. <http://archive.gao.gov/t2pbat1/154853.pdf> (accessed 8 March 2012). This report assesses Space Shuttle program cost reductions, past and future, and the effects of these reductions on safety. So far, NASA has reduced its cumulative funding for Shuttle operations by 22 percent, from FY 1992 to FY 1995, and its actual operating costs by 8.5 percent, between FY 1992 and 1994. The GAO report found that, although additional funding reductions are necessary to achieve NASA's future budget projections, NASA may not be able to reduce its costs without affecting Shuttle safety and jeopardizing the ISS program.
- U.S. General Accounting Office. "Space Shuttle: Upgrade Activities and Carryover Balances." Report no. GAO/T-NSIAD-98-21, Washington, DC, 1 October 1997. <http://www.gao.gov/archive/1998/ns98021t.pdf> (accessed 8 March 2012). In this report, the GAO analyzes NASA's plan to take US\$190 million from the Space Shuttle program to help offset additional costs of the ISS. The GAO notes that the transfer of the funds to the ISS program does not adversely affect current or near-term Shuttle upgrade projects.
- U.S. General Accounting Office. "Space Station: Cost Control Difficulties Continue." Report no. GAO/NSIAD-96-135, Washington, DC, July 1996. <http://www.gao.gov/archive/1996/ns96135.pdf> (accessed 8 March 2012). This report describes cost overruns on the ISS. As of April 1996, the prime contract for the ISS was nearly US\$90 million over cost and about US\$88 million behind schedule. If available resources prove inadequate, program managers either will be forced to exceed the annual funding limitation or will have to defer or rephase other activities, potentially delaying the space station's schedule and increasing its overall cost.
- U.S. General Accounting Office. "Space Station: Cost To Operate After Assembly Is Uncertain." Report no. GAO/NSIAD-99-177, Washington, DC, August 1999. <http://www.gao.gov/archive/1999/ns99177.pdf> (accessed 8 March 2012). This GAO report analyzes the cost of operating a completed ISS. NASA said that Shuttle flights should be allocated to the overall cost of operating the space station using a marginal cost of US\$84 million per flight rather than an average cost per flight of US\$435 million. The GAO believes that the average cost per flight more accurately represents the resources NASA will spend to run the space station.
- U.S. General Accounting Office. "Space Station: Estimated Total U.S. Funding Requirements." Report no. GAO/NSIAD-95-163, Washington, DC, June 1995. <http://archive.gao.gov/t2pbat1/154552.pdf> (accessed 7 March 2012). This report, which focuses on spending for the ISS, questions whether the Space Shuttle program can support the space station's launch and assembly requirements.
- U.S. General Accounting Office. "Space Station: Impact of the Expanded Russian Role on Funding Research." Report no. GAO/NSIAD-94-220, Washington, DC, 21 June 1994. <http://archive.gao.gov/t2pbat3/151975.pdf> (accessed 7 March 2012). This report focuses on cost savings attributable to increased Russian participation in the ISS.

- U.S. General Accounting Office. "Space Station: Impact of the Grounding of the Shuttle Fleet." Report no. GAO-03-1107, Washington, DC, September 2003. <http://www.gao.gov/new.items/d031107.pdf> (accessed 7 March 2012). This report discusses the status of the ISS's assembly and research plans, cost implications for the program, and concerns about whether NASA will be able to continue assembling the space station in the wake of the loss of Space Shuttle *Columbia*. The GAO finds that, because of NASA's grounding of the Shuttle fleet subsequent to the *Columbia* disaster, the space station will cost more and take longer to complete, delaying key research objectives. The partners must now rely on the limited payload capacity of Russia's spacecraft, Soyuz and Progress, to rotate crew and provide logistics support, placing the ISS in survival mode.
- U.S. General Accounting Office. "Space Station: Information on National Security Applications and Cost." Report no. GAO/NSIAD-93-208, Washington, DC, May 1993. <http://archive.gao.gov/t2pbat5/149216.pdf> (accessed 8 March 2012). The report describes the cost of Space Station Freedom, a NASA project to construct a permanently piloted Earth-orbiting space station in the 1980s. Although approved by President Ronald W. Reagan and announced in the 1984 State of the Union Address, the proposed Space Station Freedom was never constructed or completed as originally designed. After several cutbacks, the remnants of the project became part of the ISS.
- U.S. General Accounting Office. "Space Station: Program Instability and Cost Growth Continue Pending Redesign." Report no. GAO/NSAID-93-187, Washington, DC, 18 May 1993. <http://archive.gao.gov/t2pbat6/149194.pdf> (accessed 7 March 2012). This report describes cost estimates and real costs for Space Station Freedom. All Space Shuttle flights from FY 1988 through FY 2000 will be devoted to assembling the space station. The proposed Space Station Freedom was never constructed or completed as originally designed, but the remnants of the project became part of the ISS.
- U.S. General Accounting Office. "Update on the Impact of the Expanded Russian Role." Report no. GAO/NSAID-94-248, Washington, DC, 29 July 1994. <http://archive.gao.gov/t2pbat2/152266.pdf> (accessed 6 March 2012). This report describes the economic benefits of Russia's participation in the ISS. The GAO found that Russian participation in the space station program offered no net savings that NASA could use to fund other program areas and to accelerate the station's assembly schedule. In fact, Russian participation could add US\$400 million in program funding requirements because of lower than anticipated hardware contributions.
- U.S. Government Accountability Office. "NASA: More Knowledge Needed To Determine Best Alternatives To Provide Space Station Logistics Support." Report no. GAO-05-488, Washington, DC, May 2005. <http://www.gao.gov/new.items/d05488.pdf> (accessed 7 March 2012). This report reviews NASA's assessment that returning the Space Shuttle to flight was the best option for providing support to the ISS. Combining information gathered from commercial industry and a better definition of space station and Shuttle requirements, NASA officials agree there is an opportunity to perform a more comprehensive assessment of alternatives, especially for logistics missions late this decade.

Van de Haar, Rudolf. “STS-126: Mission Doubles Up Crew Capacity.” *Spaceflight*, February 2009. This article discusses STS-126, Space Shuttle *Endeavour*’s mission to deliver construction equipment to the ISS and to service the Solar Alpha Rotary Joints. The author describes crew members, daily activities, launch preparation, and payloads during the 15-day mission.

Van de Haar, Rudolf, Rudolf van Beest, and Clive Simpson. “STS-121: Back to Back for Discovery.” *Spaceflight*, September 2006. This article discusses STS-121, Space Shuttle *Discovery*’s mission to deliver equipment and supplies to the ISS and to demonstrate techniques for inspecting and protecting the Shuttle’s thermal protection system. The author describes crew members, daily activities, launch preparation, and payloads during the 12-day mission.

[Link to Part 1 \(1970–1991\), Chapter 13—The Shuttle in International Perspective](#)

CHAPTER 18—THE END OF THE SPACE SHUTTLE PROGRAM

Asker, James R. “Radical Upgrades Urged To Cut Shuttle Costs.” *Aviation Week & Space Technology*, 29 November 1993. This special report explains what NASA could do to keep the Space Shuttle flying until 2030. One idea is to replace the solid rocket boosters with winged, liquid-fuel boosters that would be flown back to land on a runway after they drop off the Shuttle orbiter’s external tank stack two minutes into flight. The author also reviews possible changes to the Shuttle’s exterior, reaction-control systems, auxiliary power units, and payload bay.

Brandon-Cremer, Lee, and Joel Powell. *Space Shuttle Almanac*. Calgary, AB: Microgravity Productions, 1992. http://www.amazon.com/Space-Shuttle-Almanac-ebook/dp/B005IWAVOA/ref=sr_1_8?s=books&ie=UTF8&qid=1323720909&sr=1-8 (accessed 8 March 2012). In this final digital edition of the *Space Shuttle Almanac*, primary author Lee Brandon-Cremer celebrates 40 years of Shuttle operational history within a 1,400-page compilation of mission facts, figures, dates, and times. The almanac includes an outstanding collection of more than 1,000 photographs and more than 1,000 diagrams, covering every mission. The e-book is available on CD or by download.

Broad, William J. “Fears of Decline and Demoralization at NASA as the Shuttle Program Ends.” *New York Times*, 4 July 2011. As NASA prepares to launch its last Space Shuttle—ending 30 years in which large teams of creative scientists and engineers sent winged spacecraft into orbit—it faces a potentially greater challenge: a brain drain that threatens to undermine safety, as well as jeopardizing NASA’s plans.

Brumfiel, Geoff. “Replacing the Space Shuttle: On Wings and a Prayer.” *Nature* 421, no. 6924 (13 February 2003): 684. This article focuses on NASA’s two-pronged effort to replace the Space Shuttles. One NASA effort would develop an Orbital Space Plane within 10 years, using conventional launch technologies. The other effort is an open-ended concept study with no time limit. Reducing fuel weight is a goal set for each effort.

Brumfiel, Geoff. “Space Exploration: Where 24 Men Have Gone Before.” *Nature* 445, no. 7127 (2 January 2007): 474–478. The article discusses challenges to NASA’s space exploration efforts and the new Space Shuttle craft that NASA plans to use by 2020.

Chang, Kenneth. “With ‘Coolest Job Ever’ Ending, Astronauts Seek Next Frontier.” *New York Times*, 24 April 2011. The author reports that, as the Space Shuttle program ends, the likelihood of human spaceflight to an interesting destination anytime soon is decreasing. Consequently, astronauts are experiencing low morale.

Dicht, Burton. “Shuttle Diplomacy.” *Mechanical Engineering*, July 2011. With the Space Shuttle era coming to a close and the final flight of *Atlantis* scheduled for July 2011, the author of this article discusses the history of the Space Shuttle program and the future of the U.S. human spaceflight program after it ends. Assessing the costs of the Space Shuttle and its contributions to the space program, the author suggests that, although the reusable

spacecraft is a remarkable flying machine, it has not achieved the goal that led to its creation—to reduce the cost of delivering humans and large payloads into space.

Duggins, Pat. *Final Countdown: NASA and the End of the Space Shuttle Program*. Gainesville, FL: University Press of Florida, 2009. This book describes the Space Shuttle program from beginning to end, including the early Shuttle plans and many of the Space Shuttle missions. The author interviews Shuttle astronauts and writes about the impending demise of the Space Shuttle. The book also examines the plans for NASA's next major spacecraft system and the early phase of its development.

Fountain, Henry. "Shuttles, Turning Sedentary, Leave Pieces Behind for Science and Safety." *New York Times*, 2 June 2011. Although it is preparing to end the Space Shuttle program, NASA does not plan to ship the retired Shuttles to museums complete with all of their parts. Crews preparing for the retirement of the spacecraft are inundated with requests to retain many Shuttle parts for analysis, including the Shuttles' valves, flight-control instruments, and even their tires and windows.

Gale, Morrison. "Shuttle Diplomacy." *Mechanical Engineering*, March 1999. This article discusses how a National Research Council (NRC) report to NASA significantly influenced the policy decision that determined the fate of the Space Shuttle program. A special committee of the NRC recommended that NASA make 25 upgrades to the Space Shuttle, causing NASA to reconsider whether the Shuttle would continue to operate after 2012.

Griffin, Gerry. "As Shuttle Retires, a Vote for Commercial Space Flight." *USA Today*, 6 April 2011. The author reports that, because it will not have low-Earth-orbit transportation capability after the Space Shuttle program ends, NASA will not be able to explore and learn more about space. Furthermore, NASA will not be able to conduct piloted spaceflight once the Space Shuttle retires. However, the author believes that the commercial spaceflight industry shows encouraging signs that it may develop the capability of conducting human spaceflight in the near future.

Harpole, Tom. "Throttle Down." *Air & Space*, November 2010. This article discusses the prospective end of the Space Shuttle program and the closing of NASA's Kennedy Space Center. The author notes that closing Kennedy Space Center will lead to the loss of an estimated 9,000 NASA jobs and will have an effect on the economy of the region in Florida where it is located.

"Keep to the Vision." *Nature* 459, no. 7243 (July 5, 2009): 9–10. The article reflects on the possibility of continuing the Space Shuttle fleet past the year 2010.

Kremer, Ken. "Space Shuttle Processing Facilities." *Spaceflight*, April 2009. This article describes NASA's typical work process to ready a Shuttle for flight and to unload, inspect, repair, clean, and test the Shuttle upon its return to Earth. In addition, the author describes the facilities and equipment that NASA uses to process Shuttles, as well as the

tasks performed at NASA's Kennedy Space Center between Space Shuttle launches. Once the Space Shuttle retires, NASA will no longer need staff to perform these tasks.

- Lawler, Andrew. "After Columbia, a New NASA?" *Science* 299, no. 5609 (14 February 2003): 998. The author believes that the *Columbia* tragedy will result in a dialogue between Congress and NASA that will determine the direction of the U.S. space program over the next 20 years and will ultimately have a beneficial effect on space policy. NASA Administrator Sean O'Keefe hopes to build a complement to the Space Shuttle, to revolutionize space science missions, and to create the framework for human missions beyond Earth orbit.
- Leary, Warren E. "NASA Starts Planning To Retire Space Shuttle." *New York Times*, 2 April 2005. Even as NASA prepared to resume flights of the Space Shuttle, a top NASA official reported that NASA had begun to form detailed plans to retire the spacecraft in five years, if not sooner.
- Leary, Warren E. "Shuttle Retirement May Bring Loss of 8,600 Jobs, NASA Says." *New York Times*, 2 April 2008. In response to a congressional order, NASA released its first estimates of anticipated job losses during its transition from the Space Shuttle program to the Constellation program. NASA estimates the loss of 8,000 contractor jobs and 600 civil service jobs.
- Martin, Benjamin P. "Space Shuttle Re-envisioned." *Ad Astra*, Spring 2007. This article focuses on the capabilities of a proposed new, unnamed orbiter like the Space Shuttle. According to the author, the new orbital spacecraft's fixed-wing concept does not use propellants. It will take off vertically, along with an attached tanker that will supply all of the propellants for both vehicles. The design of the new spacecraft diminishes the dynamic penalties of structures pushing against each other during their ascent trajectory.
- Morgan, Daniel. "The Future of NASA: Space Policy Issues Facing Congress." CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 7 August 2010. http://assets.opencrs.com/rpts/R41016_20100708.pdf (accessed 8 March 2012). The report reviews President George W. Bush's Vision for Space Exploration; the findings of the U.S. Human Space Flight Plans Committee, which President Bush appointed to report on the future of human spaceflight in the United States; President Barack H. Obama's cancellation of the Constellation program; and congressional hearings regarding the extension of the Space Shuttle program beyond 2011.
- Morgan, Daniel, and Carl E. Behrens. "National Aeronautics and Space Administration: Overview, FY 2008 Budget in Brief, and Key Issues for Congress." CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 14 March 2007. http://assets.opencrs.com/rpts/RS22625_20070314.pdf (accessed 8 March 2012). This report discusses the FY 2008 US\$17.309 billion budget request for NASA, an increase of 6.5 percent from the FY 2007 appropriation of US\$16.247 billion. Other issues addressed include the President's Vision for Space Exploration, development of new vehicles for human spaceflight, plans for the transition to these vehicles after NASA

retires the Space Shuttle in 2010, and NASA's efforts to balance its priorities between human exploration and its other activities in science and aeronautics.

- Morgan, Daniel, and Carl E. Behrens. "National Aeronautics and Space Administration: Overview, FY 2009 Budget, and Issues for Congress." CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 26 February 2008. http://assets.opencrs.com/rpts/RS22818_20080226.pdf (accessed 8 March 2012). This report discusses NASA's FY 2009 budget request of US\$17.614 billion, an increase of 1.8 percent from the FY 2008 appropriation of US\$17.309 billion. The report explains the importance of implementing the President's Vision for Space Exploration, including the development of new vehicles for human spaceflight, plans for the transition to these vehicles after NASA retires the Space Shuttle in 2010, and NASA's efforts to balance its priorities between human exploration and its other activities in science and aeronautics.
- Morring, Frank, Jr. "Commercial Break; NASA Plans COTS-Only Approach for ISS, Dropping Russia's Progress." *Aviation Week & Space Technology*, 21 April 2008. This article reports that NASA officials will discuss with Congress a plan for NASA to continue using Russia's Soyuz crew launch vehicles to transport astronauts to and from the ISS after the final Space Shuttle flight in 2010. NASA does not intend to continue using Russian Progress vehicles for U.S. cargo resupply but plans to use its own Commercial Orbital Transportation System (COTS) program vehicles, which are as yet untested.
- Neal, Valerie. "Space Policy and the Size of the Space Shuttle Fleet." *Space Policy* 20, no. 3 (August 2004): 157–169. The author describes arguments for and against changes to the size of the Shuttle fleet and the influence of those arguments on NASA's policy and plans for after the retirement of the Space Shuttle. The author also discusses the size of the Shuttle fleet after the *Challenger* accident.
- Reuters. "Panel Agrees To Protect Jobs, Add Mission for Space Shuttle." *Washington Post*, 16 July 2010. Reuters reports that the Senate Commerce, Science, and Transportation Committee has unanimously passed a plan to postpone retirement of the Space Shuttle. In addition, the committee agreed to include in NASA's three-year spending plan an additional Space Shuttle mission to the ISS.
- Saslow, Rachel. "A Man Who Spent Years at NASA and 35 Days in Space." *Washington Post*, 5 July 2011. The author interviews former Space Shuttle astronaut Piers J. Sellers about his memories of spaceflight and the end of the U.S. Space Shuttle program.
- Smith, Marcia S. "Space Exploration: Issues Concerning the 'Vision for Space Exploration.'" CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 6 September 2005. http://assets.opencrs.com/rpts/RS21720_20050609.pdf (accessed 8 March 2012). This report provides an overview of President George W. Bush's 2004 Vision for Space Exploration and congressional reaction to the Vision, which includes terminating the Space Shuttle program in 2010.

- Smith, Marcia S., and Daniel Morgan. "The National Aeronautics and Space Administration's FY 2005 Budget Request: Description, Analysis, and Issues for Congress." CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 12 October 2004. http://assets.opencrs.com/rpts/RL32676_20041210.pdf (accessed 8 March 2012). The report describes NASA's FY 2005 budget of US\$16.070 billion, a 4.5 percent increase over NASA's FY 2004 appropriation of US\$15.378 billion. According to President George W. Bush's Vision for Space Exploration, NASA will focus its activities on returning humans to the Moon by 2020 and someday sending them to Mars and to "worlds beyond."
- Smith, Marcia S., and Daniel Morgan. "The National Aeronautics and Space Administration's FY 2006 Budget Request: Description, Analysis, and Issues for Congress." CRS Report for Congress, Congressional Research Service, Library of Congress, Washington, DC, 17 November 2005. http://assets.opencrs.com/rpts/RL32988_20051117.pdf (accessed 8 March 2012). This report describes NASA's FY 2006 budget and the congressional debate over NASA's future programs. NASA requested US\$16.456 billion, 2.4 percent more than the US\$16.070 billion Congress appropriated in FY 2005. NASA Administrator Michael D. Griffin is accelerating development of a crew exploration vehicle.
- Trabucco, Peter. "What's Next for NASA After the Space Shuttle?" *Ad Astra*, Fall 2010. This article focuses on the state of the U.S. space program and the future of NASA. Because of space program budget cuts, employees of NASA's Johnson Space Center could lose their jobs after the last Space Shuttle returns from space.
- U.S. Congress. Congressional Budget Office. *A Budgetary Analysis of NASA's New Vision for Space Exploration*. Report, Washington, DC, 2 September 2004. <http://www.cbo.gov/ftpdocs/57xx/doc5772/09-02-NASA.pdf> (accessed 8 March 2012). In this report analyzing NASA's budget request for FY 2005 and NASA's budget projection through 2020, the CBO assesses the implications of NASA's budget plans on the content and schedule of NASA's future activities, including the operation of the Space Shuttle and the United States' participation in the ISS. Funding would enable NASA to develop new vehicles for spaceflight, allowing humans to return to the Moon by 2020.
- U.S. Congress. Congressional Budget Office. *Analysis of NASA's Plans for Continuing Human Spaceflight After Retiring the Space Shuttle*. Report, Washington, DC, November 2008. http://www.cbo.gov/ftpdocs/98xx/doc9886/11-03-NASA_Letter.pdf (accessed 8 March 2012). This report describes the status of NASA's Constellation program, which funds the development of new vehicles, including the Ares-1 crew launch vehicle and the *Orion* crew exploration vehicle intended for future human spaceflight to the Moon, Mars, and beyond. The report also evaluates NASA's prospects for achieving its goals.
- U.S. Congress. Congressional Budget Office. *The Budgetary Implications of NASA's Current Plans for Space Exploration*. Report, Washington, DC, April 2009. <http://www.cbo.gov/ftpdocs/100xx/doc10051/04-15-NASA.pdf> (accessed 8 March 2012). This report provides cost projections based on NASA's current plans for retiring the Space Shuttle and the extension of the Space Shuttle program into 2015. The extension would enable NASA to

eliminate the gap between the Shuttle's retirement and the initial operating capability of other spacecraft, so that the United States' ability to conduct human spaceflight would not be compromised.

- U.S. Congress. House of Representatives. Committee on Science. *Implementing the Vision for Space Exploration: Development of the Crew Exploration Vehicle*. 109th Cong., 2nd sess., 28 September 2006. <http://www.gpo.gov/fdsys/pkg/CHRG-109hhr29949/pdf/CHRG-109hhr29949.pdf> (accessed 12 March 2012). This hearing summarizes the development of the program that will build the *Orion* crew exploration vehicle, including an overview of potential challenges to the program's implementation and sustainability and a discussion of budgetary concerns. For the Orion program, which would rely on Shuttle-derived technologies, NASA must use Space Shuttle personnel, assets, and infrastructure to develop a crew exploration vehicle, a crew launch vehicle, and a heavy-lift launch vehicle.
- U.S. Congress. House of Representatives. Committee on Science. Subcommittee on Space and Aeronautics. *Space Shuttle and Space Launch Initiative*. 107th Cong., 2nd sess., 18 April 2002. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest Congressional). This hearing reviews proposed Space Shuttle safety and performance upgrades and examines the NASA Space Launch Initiative, a program for research into the development and commercial applications of advanced and alternative space transportation technologies, including RLV development.
- U.S. Congress. House of Representatives. Committee on Science. Subcommittee on Space and Aeronautics. *Space Transportation, Parts I–IV*. 106th Cong., 1st sess., 29 September; 13–27 October 1999. <https://web.lexis-nexis.com/congcomp/> (accessed 11 November 2011 via Proquest Congressional). This hearing reviews the status of NASA's RLV program, including the X-33 RLV demonstration program; assesses private-sector efforts to develop RLVs using private capital; evaluates proposed safety and performance upgrades to the Space Shuttle; and examines the development of future space transportation systems.
- U.S. Congress. House of Representatives. Committee on Science and Technology. *Options and Issues for NASA's Human Space Flight Program: Report of the "Review of U.S. Human Space Flight Plans" Committee*. 111th Cong. 1st sess., 15 September 2009. <http://www.gpo.gov/fdsys/pkg/CHRG-111hhr51928/pdf/CHRG-111hhr51928.pdf> (accessed 6 March 2012). This hearing examines the findings of the U.S. Human Spaceflight Plans Committee's independent review of current U.S. human spaceflight plans and possible alternatives, identifying options to enable continued human spaceflight beyond the Space Shuttle's retirement.
- U.S. Congress. House of Representatives. Committee on Science and Technology. Subcommittee on Space and Aeronautics. *NASA's International Space Station Program: Status and Issues*. 110th Cong., 2nd sess., 24 April 2008. <http://www.gpo.gov/fdsys/pkg/CHRG-110hhr41799/pdf/CHRG-110hhr41799.pdf> (accessed 7 March 2012). This hearing examines the challenges and risks facing the ISS program in light of the decision to retire the Space Shuttle in 2010.

- U.S. Congress. Senate. Committee on Commerce, Science, and Transportation. Subcommittee on Science and Space. *Assessing Commercial Space Capabilities*. 111th Cong., 2nd sess., 18 March 2010. http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=111_senate_hearings&docid=f:66983.pdf (accessed 14 March 2012). This hearing examines commercial space capabilities and developments in light of the President George W. Bush administration's decision to discontinue the Space Shuttle program in favor of expanded commercial-sector contracting, under NASA oversight, for transportation of astronauts to the ISS and for further exploration.
- U.S. Congress. Senate. Committee on Commerce, Science, and Transportation. Subcommittee on Science and Space. *Options from the Review of U.S. Human Spaceflight Plans Committee*. 111th Cong., 1st sess., 16 September 2009. http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=111_senate_hearings&docid=f:54289.pdf (accessed 12 March 2012). This hearing examines the findings of the U.S. Human Spaceflight Plans Committee's independent review of current U.S. human spaceflight plans and possible alternatives, identifying options to enable continued human spaceflight beyond the Space Shuttle's retirement.
- U.S. Congress. Senate. Committee on Commerce, Science, and Transportation. Subcommittee on Space, Aeronautics, and Related Sciences. *Issues Facing the U.S. Space Program After Retirement of the Space Shuttle*. 110th Cong., 1st sess., 15 November 2007. In this hearing, NASA witnesses discuss various aspects of the U.S. space program after NASA retires the Space Shuttle, including the status of space transportation in support of the ISS.
- U.S. Congress. Senate. Committee on Commerce, Science, and Transportation. Subcommittee on Space, Aeronautics, and Related Sciences. *Transitioning to a Next Generation Human Space Flight System*. 110th Cong., 1st sess., 28 March 2007. <http://www.gpo.gov/fdsys/pkg/CHRG-110shrg39519/pdf/CHRG-110shrg39519.pdf> (accessed 14 March 2012). This hearing reviews NASA's plans for the transition from the Space Shuttle program to the Constellation program, including projects to develop the Ares crew launch vehicle and the *Orion* crew exploration vehicle. The hearing also examines NASA's efforts to minimize the anticipated time gap between the last Space Shuttle flight and the first planned launch using the new system. In addition, it assesses NASA's efforts to sustain the Space Shuttle workforce while developing the new spaceflight system.
- U.S. General Accounting Office. "Space Transportation: Status of the X-33 Reusable Launch Vehicle Program." Report no. GAO/T-NSIAD-99-243, Washington, DC, 29 September 1999. <http://www.gao.gov/archive/1999/ns99243t.pdf> (accessed 8 March 2012). The report focuses on the possible phaseout of the Space Shuttle and its replacement with commercial launch services. The GAO remarks that the program will not meet some of its original cost, schedule, and performance objectives because of problems developing technologies for the X-33 VentureStar. In addition, the report states that the X-33 will not carry as much cargo as the Space Shuttle and will have to dock at the ISS more frequently than the Shuttle does.

- U.S. Government Accountability Office. “NASA: Agency Has Taken Steps Toward Making Sound Investment Decisions for Ares I But Still Faces Challenging Knowledge Gaps.” Report no. GAO-08-51, Washington, DC, October 2007. <http://www.gao.gov/new.items/d0851.pdf> (accessed 8 March 2012). This report examines the Ares 1 and the *Orion* crew exploration vehicle as the replacement system for the Space Shuttle. NASA has not yet developed the knowledge necessary to make sound investment decisions for the Ares-1 project. The principal gaps in NASA’s knowledge concern the project’s requirements, costs, schedule, technology, design, and production feasibility. Continued instability in the design of the *Orion* crew exploration vehicle is hampering NASA’s efforts to establish firm requirements for the Ares-1 project.
- U.S. Government Accountability Office. “NASA: Progress Made on Strategic Human Capital Management, but Future Program Challenges Remain.” Report no. GAO-07-1004, Washington, DC, 8 August 2007. <http://www.gao.gov/new.items/d071004.pdf> (accessed 6 March 2012). This report examines NASA’s efforts to recruit, develop, and retain certain critical skills in its workforce, guided by its strategic human capital management plan, while working to replace the Space Shuttle with the next generation of human spaceflight systems. NASA is considering how best to mitigate the potential loss of skills and knowledge during the period from the Space Shuttle’s retirement in 2010 to the resumption of human spaceflight in 2015.
- U.S. Government Accountability Office. “NASA Supplier Base: Challenges Exist in Transitioning from the Space Shuttle Program to the Next Generation of Human Space Flight Systems.” Report no. GAO-07-940, Washington, DC, July 2007. <http://www.gao.gov/new.items/d07940.pdf> (accessed 8 March 2012). This report examines NASA’s plans and processes for managing its supplier base through the Shuttle’s retirement and the transition to the Constellation program’s exploration activities. The report recommends that the NASA Administrator instruct the Exploration Systems Mission Directorate and the Space Operations Mission Directorate to develop cost estimates for transition and retirement activities beyond FY 2010 jointly, so that NASA can include in its FY 2009 budget submission the transition and retirement funding through FY 2013.
- U.S. Government Accountability Office. “Space Shuttle: Actions Needed To Better Position NASA To Sustain Its Workforce Through Retirement.” Report no. GAO-05-230, Washington, DC, March 2005. <http://www.gao.gov/new.items/d05230.pdf> (accessed 6 March 2012). This GAO report discusses President George W. Bush’s Vision for Space Exploration, which directs NASA to retire the Space Shuttle following completion of the ISS. The retirement process, which will last several years, will affect thousands of critically skilled NASA civil service employees and contractors supporting the Space Shuttle program. The key to implementing the Vision is NASA’s ability to sustain its workforce to support safe Shuttle operations until NASA has completed the spacecraft’s retirement.
- Watson, Traci. “U.S. Human Spaceflight and the Road Ahead.” *USA Today*, 26 January 2011. This short article describes Shuttle flights, from the beginning of the Shuttle era through

the life of the Space Shuttle program, as well as outlining the future of the Shuttle and speculating on what will happen after NASA retires the spacecraft.

CHAPTER 19—MEMOIRS ABOUT THE SPACE SHUTTLE

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- Harris, Bernard A., Jr. *Dream Walker: A Journey of Achievement and Inspiration*. Austin, TX: Greenleaf Book Press Group, 2010. This book by Bernard A. Harris Jr., Mission Specialist on STS-55 and Payload Commander on STS-63, describes Harris's modest background and his experiences in college, medical school, and during training as a NASA flight surgeon. Harris was the first African American to walk in space.
- Jones, Thomas D. *Sky Walking: An Astronaut's Memoir*. New York: HarperCollins, 2007. The author of this book, astronaut Thomas D. Jones, flew on several Space Shuttle missions—STS-59 and STS-68 in 1994, STS-80 in 1996, and STS-98 in 2001. During those missions, Jones spent more than 19 hours spacewalking outside the Space Shuttle. Jones writes of the excitement of launch and of the experience of working in space with cosmonauts from the former Soviet Union. The book also describes the difficulties of participating in astronaut training and the emotional toll of training and missions on astronauts' families.
- Mullane, R. Mike. *Liftoff! An Astronaut's Dream*. Parsippany, NJ: Silver Burdett, 1995. The author, a former astronaut, describes his experiences in space and shares his ideas about the future of spaceflight.
- Mullane, Mike. *Riding Rockets: The Outrageous Tales of a Space Shuttle Astronaut*. New York: Simon and Schuster, 2007. The author, former U.S. Air Force Colonel Richard Michael "Mike" Mullane, was Space Shuttle mission specialist on STS-27, STS-36, and STS-41. In his autobiography, Mullane describes clashes between astronauts with military experience and those with an academic background. He also discusses how his relationships with female astronauts changed over time.
- Reichhardt, Tony, ed. *Space Shuttle: The First 20 Years—The Astronauts' Experiences in Their Own Words*. New York: Dorling Kindersley, 2002. This book, compiled by the editors of *Air & Space* and *Smithsonian* magazines, documents the history of the Space Shuttle program based on astronauts' anecdotes and reminiscences. The book includes 77 first-person accounts, including astronauts' descriptions of their experiences in zero gravity and their fear of failing in their missions.
- Scott, Winston E. *Reflections from Earth Orbit*. Burlington, ON: Apogee, 2005. In this book, former naval aviator and astronaut Winston E. Scott recounts the obstacles he overcame to enter college, become a naval aviator, and gain entrance into astronaut training. Scott,

who flew aboard STS-72 in 1996 and STS-87 in 1997 as a mission specialist describes the realities of living in space, emphasizing the routine aspects of life in space.

[Link to Part 1 \(1970–1991\), Chapter 12—Shuttle Astronauts](#)

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